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THE YOUTHFUL ELECTRICAL ENGINEER.

"THE youthful aspirant to the honourable profession of electrical engineering," says Sir William Thomson, "ought to learn mathematics and dynamics; after having the elements of a good general education, he ought to learn a good deal of chemistry and regular mechanical and civil engineering *besides electricity*." We quite agree with Sir William when he asserts that "engineering" must form an important part of the modern electrician's curriculum, but we would warn the youthful aspirant against the idea that "electricity" can be learned in a few months. Indeed, we have now specialists in "electricity" who are devoting their entire attention to a single branch of electrical science, and with all their industry and application they find it difficult to keep in the front ranks, and among these are men who had a thorough engineering education to begin with. There is no danger in learning too much, but in these days of close competition there is the danger of learning things which are not absolutely necessary, and of neglecting studies which are specially useful in some branch of the profession. Take mathematics, for instance. Here we find that different branches of mathematics demand different efforts for their comprehension, and even call into activity different intellectual faculties. "Mathematics" and "engineering" are broad terms, and unless the youthful aspirant is guided by practical men he may grow mad over the immensity of the task before him.

The average electrical engineer requires but an elementary knowledge of mathematics, and even if he has mastered the higher branches, he will seldom find time to apply them, though the desire of doing so may be frequent and tempting. The creative minds of Watt, Stephenson, Telford, and Whitworth, although never trained to the study of mathematics, have given us our steam engines, our railways, and our canals, and it must be conceded that there is a vast field of useful mechanical and electrical knowledge in which a man may work successfully for the good of his profession without being competent to follow the symbolical reasoning of a mathematical treatise. There are numbers of men who will when endowed with common sense comprehend many a complicated piece of mechanism with no further aid than that derived from patient thought upon the principles involved and a careful comparison of the successful steps which have led previous inventors to some complete and final result. Such men will, when mathematical analysis is requisite, consult competent mathematicians who make this branch of study a profession. We do not depreciate the value of universal knowledge or learning, but we know from experience that the great majority of electrical engineers cannot approach the ideal of Sir William Thomson, yet they are doing the bulk of the good work in the most efficient manner when guided by a gifted and particularly developed mind. We would advise the youthful aspirant to learn all he can about the special subject he wishes to excel in first, and to employ spare time in the study of subjects more remotely connected with his calling.

AMONG the addresses delivered before an electrical society there have been few, if any, which have displayed such a high standard of thought and research as Sir William Thomson's inaugural address. The generality of the assembly must have been impressed with a sense of deep humility, for we fancy there could have been but few present who were able to thoroughly grasp the full signification of the facts presented to them. The majority of his hearers were, however, content to accept the elaborate calculations, the profound research, and the results evolved as sufficiently proven when enunciated by such a high authority. The value of such teaching—in itself, perhaps, taxing too greatly the general power of assimilation—could hardly fail to be appreciated as pointing out the direction in which investigation is being conducted.

THE President placed his finger on the great defect which exists in our present system of education.

Unless the pupil is intended to follow the profession of an engineer pure and simple it is but seldom that sufficient attention is paid to a mechanical course of instruction. We would even go further than the President, and advocate the introduction of a class in mechanics in the curriculum of every school, and we would make it a matter of obligation that every pupil should pass in this class before obtaining his remove into the higher forms.

SIR WILLIAM paid a just tribute to the labours of Sir Charles Bright in the cause of submarine telegraphy. We are glad to see a so well merited recognition of these great services coming from the first President of the Institution of Electrical Engineers. It does not seem to be generally known what an important part was played by Sir Charles Bright in the realisation of an Atlantic cable, or to what extent is due to him the practical solution of what at that time was considered an almost unconquerable difficulty.

WHEN Sir William Thomson launches into figures he generally gets beyond the depths of the greater portion of his audience, so it is not to be wondered at that when he confessed to having left a bundle of calculations in a hansom cab a look of relief was visible on the countenances of many of his audience. Several of those present, no doubt, remembered the occasion when, after completely filling the black board with a series of the most complicated calculations far beyond the comprehension of nine-tenths of the assembly, Sir W. Thomson turned to the meeting and asked "Is that right?" a voice from the back seats cried "No." Presto! and, in the twinkling of an eye, every figure was erased, and the whole elaborate mathematical puzzle again commenced.

HIS interesting and profound address will afford a crumb of comfort to two very different classes of men: those who pin their faith to theory, and those who place their sole reliance on practical experience. He insisted in the early part of his address on the future electrical engineer undergoing a regular and thorough training in mechanical engineering before he tackled electricity. He thinks that if a youth is qualified in engineering, "electricity may be learned in a few months." This, we think, is very sound advice to young men who may choose electrical engineering as a profession, though we fear that most will find that they have only discovered how much they have to learn about electricity at the end of the "few months."

SO much for the importance of practice, but we think a finer example could not be found in the history of engineering, of the importance of theoretical knowledge, than the interesting account given by Sir W. Thomson of the famous calculation worked out by Prof. Stokes and himself, which formed the basis of the great Atlantic cable. In the absence of men of the highest mathematical ability capable of performing such calculations, such novel undertakings could only be carried out with the greatest waste of time and capital, or more probably they would never be attempted.

SIR W. THOMSON pointed out the growing interest that has been shown in recent years in the subject of electrical theory, and the repeated attempts that have been made to show what electricity is. The viscous fluid analogy, as he showed, was of the greatest assistance in getting a clear conception of the laws of alternating currents, and determining the best form of conductors for telephones, telegraphs, and such like cases. He admits, however, that this viscous fluid theory is a mathematical, not a physical anology, and will on that account be of less use to engineers. The analogue to electric current is not the velocity of the fluid. The elastic solid theory, with which he concluded his address, appears to promise more for non-mathematical men. An elastic solid, capable of transmitting light and electric effects, can easily be conceived, but the difficulty has always been to explain how this medium behaves as a perfect fluid towards ponderable matter. If we have rightly understood him, Sir William Thomson appears to think that such a fluid may be imagined made up of particles whose rigidity is due to gyrostatic action, and connected by elastic threads. By means of such a medium electromagnetic phenomena may be explained. We think these theories contain most suggestive matter for those of our readers who are seeking for a mechanical explanation of the phenomena of electricity and magnetism.

OUR ponderous, eminently respectable, and generally good-natured monthly contemporary, the New York *Electrical Engineer*, has had fits. Indeed, our comments upon the introduction of the Westinghouse system has convulsed its usually amiable editor, and he is now suffering from paroxysms of virtuous indignation. He vents his spleen upon us for what he is pleased to term an unmanly assault upon Prof. George Forbes, but which we imagined, in our innocence, to be but a mild comment upon the Professor's connection with a certain company here. We are also assured that the directors of this company were actuated only by the desire to get their works in operation and earning money at the earliest possible moment, and that Westinghouse's was *the* system by which dividends could be earned from the day the steam was turned on. Our whilom friend, who up till the unfortunate moment we were rash enough to express our honest convictions, had actually esteemed the REVIEW, then taunts us with the miserable failures—only, alas! too true—which make up the history of central station electric lighting in England, and he winds up by commending the counsel of those who advised that the high tension system of Mr. Westinghouse is the one which has produced the best financial results in America. We have the greatest admiration for Mr. Westinghouse both as an engineer and the organiser of great works, but we would like to know what the Edison Company, the Thomson-Houston Corporation, and other leading electrical contractors have to say upon the matter of successful financing, but, really, we suppose that the worth of our contemporary's chiding remarks can be as well gauged in the States as here. There might have been some weight attached to the article on this side if a gentleman very closely associated with the Editorial department of the *Electrical Engineer* had not been so intimately mixed up with this very excellent method of distributing electrical energy and with its introduction into England.

NOW we will ask this gentleman a question. Does he know that Mr. J. E. H. Gordon once staked his reputation upon the breakdown of the Westinghouse system in the town of Buffalo—which, at that time, was looked upon as a special and pattern installation—in five weeks, and has he ever seen the telegram sent to Mr.

Gordon shortly after, to this effect?—"Westinghouse special plant at Buffalo failed utterly. Your system and claims verified." This happened at a time when Mr. Gordon was engaged in doing his best to disparage the Westinghouse system and to exploit his own; at this moment that gentleman is one of the technical advisers to the Metropolitan Electric Supply Company. And now, esteemed contemporary, your writers should know that a man, be he an editor or a technical adviser, must be free from pecuniary interests in this or that method, even to the extent of refusing a retaining fee, if his writings or advice are to be considered either unbiased or anything like reliable.

LE Roi est mort; vive le Roi! The Phœnix has risen from its ashes, and now we learn that the Council of the Institution of Electrical Engineers has definitely decided that it is undesirable that the general meetings of the Institution should be reported in the press. We have already commented upon this question, and we can only express regret that the Council should have passed as its first measure under the new *regime* a resolution which can only be characterised as sheer folly. Will our readers kindly express their views on this new departure? Does it augur well or badly for the future of the Institution?

MESSRS. JOHNSON AND PHILLIPS inform us that their tender has been accepted by the Metropolitan Electric Supply Company, Limited, for the supply and erection of the whole of the electric lighting plant, including engines and boilers, for its central station near Southwark Bridge, and that it has been decided by the company to adopt the alternating system of Mr. Gisbert Kapp. We heartily congratulate both the Charlton firm and Mr. Kapp upon this success; but the Metropolitan Electric Supply Company seems to be most inconsistent. Only a few weeks ago we learnt that the Westinghouse system had been chosen for the reason that it was not experimental. Now we suppose Mr. Kapp's method has been adopted because it is? We live and learn.

DESPITE the opposition of the Prudential Assurance Company and various other persons who object to the projected electric underground railway, the Bill has passed the initial ordeal of examination by the Examiners on Parliamentary Standing Orders. They presented a petition alleging non-compliance with orders respecting certain preliminary technicalities, but it was overruled. It is understood that the opposition will fight the Bill through all its many stages. The railway, if sanctioned, will be nearly two miles long to begin with, and will have half a dozen stations between St. James's Street and Holborn Circus. It will lie only 12 feet below the street level, and the roof will come within about two feet of the surface. As we have already stated, it will be worked by electricity. The carriages will be lighted by incandescent lamps, and electric fans will be used for securing ventilation. The materials used and the rolling stock are to be of a new description, and on each side of the tracks there are to be enclosed galleries for housing pneumatic, steam, gas, water, hydraulic and other pipes, and also telegraph, telephone and electric lighting wires. The promoters predict that this arrangement will go a long way towards solving the problem of overhead *versus* underground wires. The capital is to be £750,000.

DOES anybody know what became of the Gordon Electric Light Company of America? Probably Mr. W. H. Johnstone or Mr. Graham Buckley could enlighten us if this query should happen to come under their notice. It seems odd that the principal patent in the Gordon "system" should have been that of John W. Howell, but the explanation is to the effect that the inventions were made almost simultaneously by Gordon in England and Howell in America. Nevertheless, when the attempt was made to float the above-mentioned company with a capital of $250,000, divided into 2,500 shares of $100 each, the total value of Gordon's patents, six in all, was estimated at $10,000, and that of Howell at $239,700! The remaining $300 represented a share each subscribed by Mr. Gordon, Mr. Johnstone and Mr. Thompson. Now, as Mr. Gordon had previously purchased the Howell patent, the figures above are rather startling, and it would be interesting to know the ultimate fate of this curiously formed association."

WHILE Mr. Gordon was in America a committee of electricians was appointed to report upon his system in comparison with others, and to make an estimate for the cost of mains for a particular district in Philadelphia. The committee is said to have approached the subject "with the jealousy which Americans naturally feel of Englishmen who endeavour to instruct them in matters of invention," and spent three weeks in endeavouring to upset the system. They, however, afterwards came to the conclusion that Gordon's plan alone fulfilled the requirements of town distribution, and the reported cost of mains was as follows:—Gordon's system, $6,200; ordinary system, $41,400. Now, if this is correct, why in the name of all that's wonderful are not the "divided mains" universally employed in preference to the "ordinary" system, whatever that convenient and elastic term may imply?

UNTIL quite recently no Act of Parliament has ever been passed contemplating the use of electrically-propelled vehicles for omnibus, parcel, van work, &c. The Highways and Locomotive Act did not in any way refer to such vehicles, as they refer to locomotives traction engines, steam rollers, &c. We are informed, however, that last year an Act of Parliament was passed which defined the licences for electrical vehicles, and the omnibus, of which we give an illustration, is the first one which has ever been licenced. There is no doubt, however, that it is in the true interests of all concerned in electrically-propelled vehicles that they should be put under some proper control. That is, some recognised authority should be able to insist that the vehicles should be equipped with the necessary appliances to render them safe and under proper control for street traffic, letting alone the fact that such an equipment will be necessary from economical points of view. There seems little doubt that the Board of Trade will be the authority which will most naturally take charge of the matter. Some might and do go so far as to aver that electrical vehicles are locomotives, and some of them certainly have been in general terms so called, but we are under the impression that they do not, as a matter of fact, come within the meaning of the Highways and Locomotives Act. We are not, however, certain on this point.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 34.)

V.—MAGNETIC FIELDS IN PRACTICE—(*continued*).

THUS far we have dealt with the waste field in machines having drum armatures, but where armatures of the ring type are employed, different results are obtained. In the Edison-Hopkinson dynamo referred to in our last article, the mean induction in the armature core was about 13,500, the magnetising force required for the core alone being therefore 12 ampère turns per centimetre. The mean length of the path taken by the lines through the armature is 13 centimetres, this giving a magnetising force of 156 ampère-turns for the induction through the core. For the induction in the two air gaps a force of 16,800 ampère turns was required. Now, suppose we take the magnet, fig. 51 (page 630, Vol. XXIII.), and insert in it a ring instead of a drum armature, what difference will be produced in the amount of waste field? Without considering whether we shall be able to get conductors on the ring equivalent to what we had on the drum, let the cross section of the former be such that the induction is 18,000, a figure very usual in this type of machine. Taking the length through the core at 13 centimetres, as before, we have a magnetising force of $13 \times 150 = 1{,}950$ ampères for the induction through the core, and assuming that the air gap remains as before, the magnetising force required for this and the armature is now 18,750 instead of 16,956 as formerly. The magnetising force is thus increased by about 10 per cent, and since the same force which produces the useful field creates the waste field, we may fairly assume that the latter outside the armature is in machines having ring armatures, at least 10 per cent. more than in those having drums. In addition to this stray field outside the armature, there is a certain waste field in its interior, some of the lines of force which enter the ring, leaving it again and straying from pole to pole in the interior space. The fields straying outside and inside depend to a certain extent upon the degree of saturation in the core. The magnetising force increases with the saturation and so, consequently, does the waste field. In the case of the Manchester machine, fig. 55 (page 692, Vol. XXIII.), Drs. Hopkinson found that the lines of force straying in the interior space of the armature were 5 per cent. of the lines confined to the cross section of the ring. Here, however, the induction reached 20,000 C.G.S. units.

Endeavouring to embody these considerations in our computation of the stray field in different types, we might say that if a ring were substituted for a drum armature in the single horseshoe magnet, fig. 51, the value of ν would be raised from 1·17 to 1·26 or so, while in the case of the double horseshoe shown in fig. 52, the increase is from $\nu = 1{\cdot}3$ to $\nu = 1{\cdot}36$. This is allowing in each case for an increase of 10 per cent. in the lines straying externally to the armature and for a number of lines straying internally equal to 5 per cent. of those confined to the ring cross section.

In the machine, fig. 55, the value of ν was found to be 1·49, a figure which, in the light of last example, seems rather high. But in this design the bedplate, part of which is bored to form the bottom pole, is extended to support the bearings, and many of the lines of force pass from the bottom pole along these extensions and stray from the top and sides of the bearings to the top pole piece without going through the armature. If instead of an extended bedplate for the bearings we had the armature supported by gun-metal brackets bolted to the magnet, ν would be reduced to about 1·36, the difference between this figure and the value 1·49 observed by the Hopkinsons being due to the method of supporting the armature from extensions of the bottom pole piece.

In the design, fig. 56, ν has probably about the same value as it has in fig. 52, it might be rather less seeing that the magnet limbs are farther apart. But no great error will be committed in taking $\nu = 1{\cdot}36$. In fig. 57 its value would be rather less because the pole pieces —omitted in the drawing—will not approach so near to each other as in figs. 55 and 56.

Unfortunately there are no figures at the author's disposal respecting the waste field in four-pole machines, figs. 58, 60, and 61, or multipolar fields, figs. 59 and 62. At best we can but guess their amount in much the same way as we have been doing hitherto. Evidently because there is a double path offered for the straying of lines from each magnet core and pole piece to adjacent ones the waste field in fig. 58 will be greater than in the two-pole type, figs. 56 and 57. In this design the pole pieces—omitted in the fig.—have to be brought into close proximity, and we should probably be very near the mark if we guessed the stray field at 50 per cent. more than in the two-pole type. For fig. 58 ν may therefore be taken at 1·53. As a first approximation ν may be considered as having the same value for the multipolar field in fig. 59.

For the single magnet four-pole machine in fig. 60, provided the magnets are lifted well off the iron bedplate, ν may be assumed as having the value = 1·25, and a similar value may be taken for fig. 61. In the multipolar field, fig. 62, we might expect the value of ν to be rather higher, and for a first trial we might take it at $\nu = 1{\cdot}3$

Now the foregoing are just so many guesses at the probable value of ν, and must be taken only as rough approximations. This value is subject to all sorts of variation, depending upon the length of the magnetic circuit, the relative lengths of its component parts, the relative cross sections of its component parts, the degree of saturation employed and the proximity of iron parts to the magnetic system. Still, ν must be known or assumed before we can calculate the ampère-turns required for the magnetisation of any machine, and though given as mere approximation, the above values will be found sufficiently near the truth for the purpose of a first calculation. When the machine is made it is a very easy matter to measure the waste field as was done by Drs. Hopkinson, and then the data obtained can be used for other machines of the same type, but it is before the machine is built, when it exists only on paper, that we wish to know with as much accuracy as possible the number of stray lines. The Hopkinsons measured the number of lines through the magnetic circuit at several cross sections, and were thus able to determine the ratio of the lines through each the particular section measured to the lines passing through the armature core. Call the lines in the latter = N. Then ν_1 N; ν_2 N; ν_3 N, will represent the lines in the air gaps, magnet limbs, and yoke respectively (fig. 63), if ν_1, ν_2, and ν_3 be the ratios of the lines passing through these parts to the lines passing through the armature. If a, a_1, a_2, and a_3 be the cross sections of armature core, air gap, magnet limbs and yoke, while L, L_1, L_2, and L_3 are their lengths, the amended expression for the ampère-turns on the magnets becomes

$$A = L\, f\left(\frac{N}{a}\right) + L_1 \cdot 8\, \frac{\nu_1 N}{a_1} + L_2\, f\left(\frac{\nu_2 N}{a_2}\right) + L_3\, f\left(\frac{\nu_3 N}{a_3}\right).$$

Here L_1 is the length of the two air gaps added, while L_2 is the length of the two magnet limbs added. In machines with drum armatures, ν_1 N is equal to N, or the lines in the air gap are equal to the lines in the armature core; but in the ring armature machines, figs. 52 and 55, the former is about 5 per cent. greater than in the latter. If we have part of the magnetic circuit of cast iron, as in fig. 55, the function for cast iron must be employed as taken from the curves, page 545, Vol. XXIII.

In the determinations of the brothers Hopkinson, the dimensions a, a_1, L, L_1, &c., of two machines of different type, figs. 55 and 65, were measured as accurately as possible. The values of ν_1. ν_2, &c., were determined by passing round the magnetic circuit at different places two or three turns of wire attached to a slowly swinging (balistic) reflecting galvanometer and observing the effect produced when the current was suddenly started

round the magnet coils and when the coils were short circuited. The number of lines passing through the armature core at the most intensely magnetised place they called 1, and in terms of this unit ν_1 ν_2, &c., are the numbers of lines passing through the other cross sections. The exact value of the lines through the armature core they knew by running the machine at a known speed and calculating the lines required through the conductors to produce the observed E.M.F. Having therefore obtained ν_1 ν_2 directly from experiment, they could calculate the induction $\frac{N}{a}$, $\frac{\nu_1 N}{a_1}$, &c., in every part of the machine, and knowing the lengths, L L_1, &c., all that had to be done to obtain the required magnetising force was to multiply each by its corresponding function $f\left(\frac{N}{a}\right)$, $f\left(\frac{\nu_1 N}{a_1}\right)$, &c., as obtained from the curves (pp. 544 and 545, Vol. XXIII.). To get the total ampère-turns, the products thus obtained were added together as in the equation given, the experimenters finding that the magnetising force thus calculated—that is, derived from a knowledge of the field distribution, of the dimensions of the machine and of previous experiments on the magnetisation of iron—agreed most closely with the magnetising force actually employed.

But besides calculating the force required for what might be termed the working field, the Hopkinsons drew the magnetisation curve as determined by their formulæ for all degrees of saturation, the agreement between the results actually observed and the curve thus predetermined being a very close one. To draw this curve we must find the ampère-turns in each component part of the circuit for different values for N.

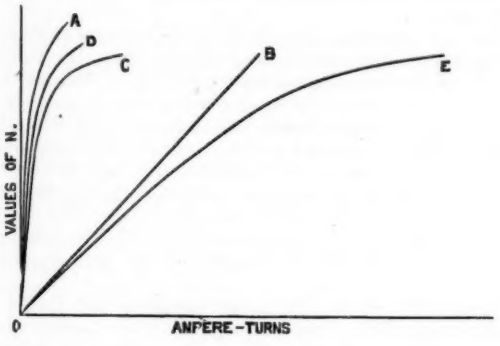


FIG. 68.

Thus in fig. 68 let abscissæ represent ampère-turns and ordinates the values of N. We plot first a curve, O, A, to represent magnetising force required in the armature for different values of N. Next we draw the line, O, B, to represent magnetising force required for the induction in the air gap. Then we draw O, C, which gives us the force for the magnet limbs, and lastly, O, D, giving us the force for the yoke. The curve, O, E, represents the sum of the ampère-turns required for all these components and is therefore the predetermined magnetising force required for the machine. It will be noticed that the values of ν_1, ν_2, &c., are assumed to be constant for all values of N. This is not strictly accurate, for, as we have seen, the waste field increases with increased induction, and ν_1, ν_2 go up in consequence. The error introduced by this assumption is, however, small, as is also the inaccuracy due to taking a constant value for ν_2 and ν_3 throughout L_2 and L_3.

These experiments of the brothers Hopkinson are most interesting and instructive, but their great practical value lies in the fact that we have here for the first time an exact determination of the waste field in two different types of dynamo, which makes it an easy matter to calculate accurately the magnetising force required for future machines of similar type, and possible to deduce roughly the waste in machines of different types. This latter we have already attempted, not analysing the distribution through different parts of the circuit, but contenting ourselves with guessing ν_2, the ratio of the total lines in the magnets to the useful lines. For an accurate determination of A it would be necessary to know absolutely the distribution in every part of the circuit, but a sufficiently close approximation is made by assuming that the ratio has the same value right round the circuit from pole piece to pole piece, the expression becoming then

$$A = L f\left(\frac{N}{a}\right) + L_1 \cdot 8 \frac{\nu_1 N}{a_1} + L_2 f\left(\frac{\nu_2 N}{a_2}\right) + L_3 f\left(\frac{\nu_2 N}{a_3}\right).$$

The effect of taking the ratio at the same value throughout the magnet limbs and yoke will be to give a somewhat stronger field than we require, this meaning nothing more serious, however, than a slight reduction of speed. For machines with drum armatures $\nu_1 = 1$, while for those with ring armatures ν_1 may be taken at 1·05.

When the first machine is constructed, all that is wanted for the construction of future machines of the same type is to know ν_2 the ratio of the lines of force in the magnets to the lines in the armature. From this, and a knowledge of the relation between the magnetising force and the magnet dimensions, any larger or smaller machines can be designed. For example, suppose we increase all the dimensions of a magnetic system n times, the induction remaining the same, and the total flux of lines being therefore $= n^2$. The cross sections of all the paths for stray lines are increased to n^2, the distances between adjacent surfaces are increased n times, and since the waste path is increased in exactly the same proportion as the useful path, the total number of stray lines will be equal to n^2 times the former number. For machines increased proportionally in their linear dimensions we see consequently that the ratio, ν_2, has the same value as in the smaller machine.

If the length of the magnetic circuit remaining the same both dimensions of the cross section are increased n times, making the area n^2, the value of ν_2 remains as before. The lines of force through the machine are n^2 times as many, and since the cross sections of the paths for the waste field are n^2 times greater, the stray lines will be increased to n^2 times their former number.

If the length of the magnetic circuit is increased n times, while the cross section and therefore the total number of lines remain as before, the ratio may be still assumed to hold. Here the cross section of the waste path remains about the same, and its length being n times greater, the waste lines straying under a magnetising force n times larger will be the same as before. If there is any difference ν_2 may be a little higher in this case.

Let the width of the magnet in fig. 52 be increased n times and the armature made n times longer, the length of each part of the magnetic circuit remaining as before. The lines of force through the machine will be n times greater, but the stray lines will not be n times as many. The facing sides of the magnets have now n times the surface, but the surfaces of the outsides, c and d, have not been increased. If the width of the magnet were several times its thickness, the increase in the stray lines would be nearly proportional to the width, or almost n times greater, causing ν_2 to have the same value as formerly, but if the thickness is comparable with the width, the value of ν_2, due to this modification, is necessarily diminished.

If the width of the magnet and the length of the armature core remain the same while their thickness is increased n times, the value of ν_2 may be considerably diminished, especially if the width is several times the thickness. This is owing to the fact that though there are now n times the number of lines through the machine, only the smaller dimension, namely, the thickness of the magnet, has been increased, while the more important dimension remains

as before. In this case, though the lines through the machine are n times greater, the increase in the waste lines may be very small, and ν_2 has therefore a smaller value.

These several considerations will enable the reader to determine with a fair amount of accuracy the effect produced as regards waste field by modifications in the dimensions of his original machine. But many designers never trouble about a determination of ν_2 at all. They assume this to have the same value for each machine, and knowing the relation of the ampère-turns on the magnets to the lines of force in the armature of the original one they deduce the ampère-turns on the magnets of modified machines with reference to the cross sections and length of the magnetic circuit only. But when this is done the lengths of the several components of the circuit must be increased or diminished in the same proportion from the original machine.

As the exact value of ν_2 is a matter of some doubt until the machine is built it may be instructive to ascertain the effect due to an error in estimating its magnitude. In the Edison-Hopkinson dynamo before described, we have for the induction in the armature core a force of 156 ampère-turns, for the induction in the air gaps 16,800 ampère-turns, and for the induction in the magnet limbs and yoke where ν_2 is 1·32, the ampère-turns are 2,650. These make a total of 19,606 ampère-turns. Assume that in designing such a machine we in error took $\nu_2 = 1{\cdot}2$ instead of its proper value 1·32. The magnetising force requisite for the magnet limbs and yoke would then be reckoned at about 2,300, and the total force 19,256. Now we know that if the permeability of the magnetic circuit were constant, the induction through every part would be simply proportional to the magnetising force, and to make the error as large as possible we will for the moment assume that the lines are proportional to the ampère-turns. The force 19,256 is about 2 per cent. less than 19,606, the forces we should have allowed, and in every part of the circuit there will be therefore 2 per cent. less lines of force. Hence an error of about 10 per cent. in ν_2 can give in the case referred to an error at most of 2 per cent. in the E.M.F. of the machine. From this it will be observed that an erroneous estimation of the waste field does not amount to much as regards the output of the machine, though it gets more serious as the magnetising force required for the magnets increases relatively to that required for other parts of the circuit.

In concluding this article it may be necessary to remind the reader that so far we have considered the magnetic field without reference to any effect which may be produced by a current flowing in the armature conductors. We have calculated the magnetising force required to produce a certain induction in the armature core, but the fact of the core being wound with a conductor and becoming a magnet when a current flows round it we have up to the present ignored. The phenomenon of self-induction has been touched upon, and we saw that the effect of stopping and starting the current in a coil was to induce lines of force through the coil which opposed the induction. We must compensate this effect then by inducing more lines through the core than if self-induction were not present. Again, when a current flows, due to the position of the collecting brushes, an effect is produced similar to that which would be produced by putting on the magnets a certain number of turns in which the current flows in an opposing direction, and this is another effect which has to be compensated. These compensations are effected by adding a certain number of ampère-turns to the magnet coils over those already determined, and their number we shall have to ascertain by and bye. We shall term them *compensating turns*, as their function is purely to compensate reactions due to the armature currents. Those already determined we shall call *effective turns*, and it is understood that the effective turns are equal to the total turns *minus* the compensating turns.

(*To be continued.*)

SECOND REPORT OF THE BOARD OF ELECTRICAL CONTROL FOR THE CITY OF NEW YORK.

IT will be remembered that great endeavours have been made in the City of New York to substitute underground conductors in place of the unsightly, and ofttimes dangerous overhead wires. A Board of Commissioners of Electrical Subways was formed to undertake the task; it may be presumed, however, that its success was not of a marked character, for in 1887, on the 5th of July, pursuant to an Act of the State Legislature, a Board of Electrical Control was organised at the office of the Mayor of the City, receiving on that occasion from the Board of Commissioners of Electrical Subways all its books, papers, and other property, and the new Board proceeded to its work. Later in the year it issued a first report, stating that the Commission consisted of four members, one of them the Mayor of the City *ex officio*, with full authority over all the electrical conductors in the City of New York, and with the special ministerial duty of changing the overhead systems to underground systems by the providing of subways suitable for occupancy by the companies doing business at present with overhead conductors.

A construction company (the Consolidated Telegraph and Electrical Subway Company) was authorised to construct the subways designed by the Commissior, and to permit the use of them by the various electrical companies upon fair and impartial terms. The local authorities, represented by the Commissioners of Public Works, have full control over the excavations of this construction company, whose profits are limited to 10 per cent. on the capital invested, any excess beyond that percentage to go to the city, and all the books and accounts of the company to be free of access by the Comptroller.

The law provides that the Board of Control shall give to operating companies ninety days notice, for the removal of their overhead wires, after a sufficient construction of subway has been made ready in any street or locality, reference being had to the general direction of the wires in use, and in the event of the companies neglecting to remove their poles and wires before the expiration of the ninety days' notice, it is provided that the local authorities shall remove them. The Board finally considered that this state of affairs was admirably adapted for the fulfilment of the task imposed upon it.

Apparently, from the above report, the Board of Control should be placed in a position to exercise absolute control over any poles or wires, provided it shall have made conduits of a capacity equal to the requirements of the condemned circuits or lengths of overhead wires. Notwithstanding this seeming unlimited power of dealing with the conductors, it will be seen by the report, issued on the 21st of December, 1888, and entitled The Second Report of the Board of Electrical Control for the City of New York, that unexpected obstacles have been thrown in its way by the *ex officio* member of its body, the Mayor of New York, who under one pretext or another has failed to issue his mandate to the Commissioner of Public Works to remove such poles and wires as are still standing in defiance of, and after the expiry of, the proper notices. Partly from this cause, as well as from the increase of electrical business of every kind, overhead wires have increased rather than diminished in number during the past year; some of this increment may arise in districts where it has not been contemplated, at present at least, to lay down subways.

This hostility to subway work on the part of the Mayor has seriously impeded the Board in its endeavours to improve the condition of the electrical conductors, and has emboldened certain electrical companies to openly defy the law.

An improvement may soon be looked for, the people having elected another Mayor, who entered on his duties at the beginning of this month, and who has pledged himself to exhaust every remedy to compel

electrical companies to comply with the provisions of the Acts requiring them to place their wires in subways. Hearty co-operation on the part of the Municipal authorities would have resulted in much greater progress than has actually taken place; it is confidently anticipated that matters will now rapidly mend.

In spite of all opposition and hindrance the board has achieved some good work, nearly 46 miles of trench having been excavated for the laying of subways capable of carrying some 35,000 miles of telephone and telegraph wire, and some 600 miles of cable for electric lighting and power service. Conduit for Edison incandescent lighting has been laid down about 60 miles in length, containing 192 miles of conductors.

The total number of miles of underground wire in operation at the time the report was drawn up amounts to 4,453 miles owned by five companies, two of which, the Brush Company and the Edison Company, are electric lighting corporations utilising 200 miles of cable conductors. The delicate electrical service of the Metropolitan Telephone Company has not deteriorated at all by the conversion from overhead to underground, but possibly it has improved a little.

The following six principles were taken as bases in designing the underground system adopted by the Board of Control :—

1. A subway or conduit is only a mechanical protection for the wires within it and a convenience for placing them.

2. Electric light and power conductors should be operated separately, and as far as possible from those for the transmission of weak currents.

3. The material and form of the subway should depend largely upon the requirements of the locality and the service for which it is designed.

4. Drawing in and out conduits with convenient manholes are, in the main, the most desirable for the streets of this city, where a condition of the law allowing the companies 90 days to place their conductors in the subways after they are constructed, necessitates that the subways shall be easily accessible without serious disturbance of the pavement.

5. The success of the underground service depends largely upon the proper insulation of the wires, and the largest liberty compatible with the rights of others should be allowed to companies using the subways.

6. The nature of local connections depend to a great extent upon the service and locality for which they are designed, and here again liberty of choice under proper restrictions may reasonably be allowed.

Proceeding on these principles in the construction of the subways and conduits, a diversity in design, size and material, has arisen to suit the various wants of the companies; having regard, also, to commercial economy and the likely requirements of the districts through which the conduits pass. It is satisfactory to find that the Board is, from the test of experience, perfectly convinced of the soundness of the premises on which it based its conclusions, and time only serves to justify it in continuing its work on similar lines. The fact that part of the existing underground service is used as a portion of the telephone circuit between New York and Boston, a distance of 200 miles, and this without any deterioration of the service between the two cities, will show beyond dispute the practicability of the underground wires to fulfil the duties for which they were laid.

Not content to rely entirely on its own judgment, the Board of Control preferred to substantiate it by the sworn testimony of those competent to form an opinion, consequently affidavits have been drawn up and sworn to by a number of gentlemen showing that the provisions for underground electrical conductors in the City of New York represent the best and most complete knowledge and experience of the subject. These affidavits, which are annexed to the report, are answers to and form rebutting evidence to others produced in the Supreme Court of the State of New York, by the United States Illuminating Company in an action against the Board of Electrical Control of the City of New York, the Commissioner of Public Works of the said City, and the Superintendent of the Bureau of Encumbrances. Had a *resumé* of the indictment been printed side by side with the counter-evidence, the value of the latter must have been further enhanced.

Before dealing with the facts elicited by these affidavits, or entering into the mechanical construction and the general details of the subways, it will not be out of place to give a short account of the present condition of the overhead wires which the underground systems are intended to replace.

So great a need for improvement in the condition of the overhead wires had arisen that the Board asked for an appropriation sufficient to enable it to employ inspectors who should be competent to investigate and report cases of improper construction and maintenance of the overhead service. As soon as this appropriation became available an electrical expert and inspectors were appointed, and since that time this work has received their entire attention.

It is found that the condition of the overhead wires in the City is very bad. The rules and regulations of the Board of Electrical Control are violated everywhere. Unnecessary and "dead" poles and wires make up from 30 to 50 per cent. of all those existing. The poles made use of and the method of construction, as well as the way in which the wires are strung, are not in accordance with proper principles nor in harmony with the character of the buildings along the streets, nor of a description enabling the freest possible use of the streets for other purposes.

The wires are almost uniformly dangerous, especially those devoted to the electric light service. They obstruct the fire department. The wires cross streets and enter the buildings irregularly, instead of at right angles as they should; the poles are crooked, unpainted, different in size and length; the cross arms upon them are irregular, and the entire construction is unsightly and improper.

On December 21st, 1888, this journal published the set of rules and regulations for overhead conductors for electric light and power adopted by the Board, and which, if followed, would relieve the overhead service from the danger and unnecessary obstruction which now attend it. Violations of these rules are being constantly reported to the Board since the system of inspection was inaugurated, exceeding in number 2,500; 1,045 notices have been sent to the several delinquents, and in case of non-compliance with notice the attention of the Department of Public Works is called to the fact, in order to have the offending structures removed.

A table is given, headed "Report of Dead Wires and Dead Poles," showing in detail the companies which have been notified and the character of the change required, as well as the number attended to, and the number of cases referred to the Bureau of Encumbrances.

Out of the total 2,588 violations of the rules, 256 useless wires and 200 useless poles have been discovered for which no owners can be found.

The result of the work of the Board has been the removal of 776 poles and 946 miles of wires, as follows :—

By the electrical companies	395 poles
By the Department of Public Works	381 poles
Total	776 poles
By the electrical companies	701 miles of wire
By the Department of Public Works	245 miles of wire
Total	946 miles of wire

These figures represent the labour of six months since the appointment of the staff of inspectors, and the importance of its work of supervising and controlling the overhead electrical conductors can hardly be over estimated.

"It has taken years to provide what may be regarded as a small area, in comparison with the whole city, with subways. These subways are not yet filled to their entire capacity, nor have the underground conductors

in them as yet wholly taken the place of all overhead conductors in the streets and avenues and localities in which they have been built.

"Under the most favourable circumstances, and with the most satisfactory progress, it must necessarily be a long time before the great bulk of all the wires in the City are underground, and even then there will be streets and avenues in which it will not be deemed proper or necessary to construct subways, and where wires will still be overhead.

"Again, there will always doubtless be overhead wires in certain parts of the City in connection with those working underground.

"Under these circumstances, and during the time which it must necessarily take to do away with the bulk of the overhead service, it is of vital importance to the people of the City and State that this overhead service shall be of the best and safest character, and interfere with the other uses to which the streets are devoted as little as possible."

The Board, in dealing with this question, has, in its endeavours to carry out a scheme in the best and most comprehensive fashion, been actuated by the following principles :—

1. All useless poles and wires must be removed from the streets.

2. All dangerous currents must be carried on insulated wires, and *the insulation must be maintained.*

3. All poles must be of a sufficient size to keep the wires away from the sidewalk sufficient to allow unobstructed operations by firemen.

4. One line of poles for wires is enough in any street or avenue, and the telephone and telegraph wires must be kept on the opposite side of the street from those devoted to electric lighting.

5. All the construction of poles and wires should be symmetrical, uniform and safe.

As a consequence, in following the above line of principles the Board, in granting permission to any company to erect a series of poles to support an overhead service of wires, has held that the said company must permit its poles to be used by any other company requiring to do so and offering proper compensation, to be determined by agreement between the parties interested, or in default of such agreement to be fixed by the Board.

Should this be strictly followed in all parts of the city where no subways have been constructed it must be of the greatest service to the public generally, would enable all electric companies to operate with equal freedom, and would secure to the consumer or utiliser of the electric current the certainty of obtaining a good service at a reasonable rate ; the symmetrical arrangement of poles and wires would be no small gain to the City at large from an artistic point of view.

It is further stated in the report that, notwithstanding the efforts of the Board to cope with the subject by the construction of underground subways, in which 4,500 miles of conductors have been placed, and by the removal of a large number of poles and wires during the year, no diminution of overhead wires in New York has resulted from this work, but there can be no doubt that the overhead wires are more numerous than they were last year.

For permitting the increase of overhead wires the Board of Control has been severely criticised, many people considering that the authorisation was contrary to the spirit of the Acts under which the Board was organised. The Board, however, takes a different view of its duty under the Act, that it was constituted not as a drag on legitimate business but merely that every precaution should be used for its reasonable and proper regulation.

That, where subways have been constructed, the companies doing business on the streets where these conduits are laid shall be compelled to use them as rapidly as possible. Many considerations of preparing suitable conductors, drawing them in, making connections, and properly testing their efficiency, enter into the problem of removing overhead wires, so that in many cases the ninety days required by law must be extended to avoid injustice to the companies and inconvenience to their customers. It does not appear desirable to use harsh measures towards those who are doing their best to take up their occupancy of the subways, but in cases of defiance or neglect of the notices of the Board of Control, the latter think that such infringements of its orders should be summarily proceeded against by the proper authorities, viz., the Mayor of the City and the Commissioners of Public Works.

The Consolidated Telegraph and Electrical Subway Company, under the immediate supervision of its chief engineer, Mr. Leonard F. Beckwith, and under the direction of the Board of Control, has constructed 44 miles of subways, rather more than half of which mileage is appropriated to the telephone and telegraph service. The above subways, with the exception of the low tension Edison incandescent lamp system, are all built on the "drawing-in" system, which provides a group of tubes extending from one manhole to another, admitting of the drawing in and out of the electrical cable. The term "duct" is used to describe a pipe or tube reaching from one manhole to another, and a number of tubes form a "conduit," and the latter, with "manholes," "handholes," "distribution boxes," &c., forms the "subway."

In commencing operations the line of subway is set out, the pavement removed, and a trench is excavated in the street to the required depth, which is usually from three to five feet deep, and in this trench is built the conduit, the trench filled in and rammed, and the pavement replaced. Different systems of grouping the tubes or ducts in the trench and different materials have been employed. Experience has shown that a main conduit consisting of several pipes which can be crowded, or curved, or kept apart, is the best adapted to overcome the numerous obstructions met with underground, and frequently saved trenching. Screw jointed asphalted wrought iron pipe, laid in hydraulic cement concrete, present the greatest tightness against the infiltration of gas and water, united with the greatest strength to resist the pressure of the street or the strain of future excavations. Excepting the Johnstone conduit, for distributing, which consists of cast iron ducts, all the electric arc light subways are of the above description.

In laying the subway, the bottom of the trench is levelled to grade and well rammed, planks being set against the sides to sustain them. A layer of concrete is laid on the bottom of the trench, on this is placed a row of pipes, another layer of concrete, then another row of pipes, and so on. The concrete on the bottom, sides and top is made much thicker than between the layers of pipe to ensure a sufficiency of resistance against external violence. On the top of the concrete is laid two-inch pine planking creosoted with 12 to 16 lbs. to the cubic foot, to prevent injury to the conduit in future excavation. The iron pipe used is wrought iron lap welded pipe of the very best quality, capable of resisting from within a pressure of 500 lbs. to the square inch ; the diameter of the tube internally is mostly $2\frac{1}{2}$ or 3 inches, and $\frac{3}{8}$ths of an inch thick. The iron coupling has a screw joint with tapering thread, and the pipes are screwed up with butting joints, affording the most efficient coupling known in regard to tightness. The pipes are protected by some means against rust.

The manholes are built with hydraulic concrete bottom, and walls of best North River bricks, laid in cement mortar. The outside of the walls is coated with cement to prevent moisture and gas from penetrating. The manholes are about 5 feet to 6 feet in size and of different depths to afford convenient access to the tubes of the conduit that terminate at and start from the inside of the walls. Access to the manholes is obtained through a cast iron head which is set on the brickwork, and which is provided with double covers. The street cover is very heavy to carry the traffic, while an inner cover, provided with a rubber gasket to prevent surface water from entering the manhole, is pressed firmly into its seat by a gun metal bolt and

crossbar, and locked with a padlock to prevent unauthorised interference with the conductors in the subway.

The above construction was adopted from the success it had achieved in Chicago, where all the later subway work is on the same principle, the earlier non-conducting conduits having proved mostly failures. All the American experts recommend lead covered cables for the lighting leads, and in the event of these being used, the conducting duct in which they are placed would not be of much consequence in affecting the general insulation of the circuit.

The following methods of distribution were suggested by the Board and are in use in New York :—

A. The manhole system of distribution specially adopted and approved by the Board of Electrical Control, and which the before-mentioned United States Illuminating Company was notified to make use of.

B. The hand-hole system of distribution now in use in parts of the City of New York and in Philadelphia.

C. The house-top system now in use in City of New York.

D. The lamp post system of distribution and therewith the house front system of distribution.

E. The house-vault system of distribution now in use in Chicago.

F. Backyard system of distribution.

And the "Johnstone" sectional underground conduit, consisting of a cast iron box made lengthwise in halves and provided with shelves and partitions of the same material.

Illustrations of all these arrangements as well as of Edison's system are given in the Appendix to the Report.

In one part of the city where the Steam Heating Company maintains an imperfect construction and allows steam to escape in large quantities from its pipes, serious damage to the conductors in the subway has been caused. This has been made a ground of attack on the system of subways, and on account of this impairment of the efficiency of the cables it is said that the whole system is a failure. As this escaping steam is equally destructive to pavements, foundations of buildings, &c., the Steam Heating Company must be compelled to remedy the evil or close their supply.

From what can be gathered in reading the affidavits of the experts on behalf of the Board of Control, the indictment of the subways by their opponents consists of many statements, for the most part of a trivial character, the most important being selected as samples.

1. That the subways are totally unfit to carry electric light wires owing to the impossibility of effective insulation and the presence of excessive induction or retardation.

The answer to this is, that whatever the induction or retardation may be, it has no apparent influence on the arc light currents, and that the insulation presents no difficulty, underground circuits having been worked for years in Chicago, where conditions generally are much the same as in New York.

2. That the ducts themselves are good conductors and carry a ground or connection with the earth ; that water is always present, as well as gas and acids to destroy the insulation of the cables.

This is only partly true, and misleading. Lead-covered cables being taken as the best protected form, the lead forms a ground on the whole length, removing clearly the objections to the duct being a ground ; and further, that the successful use of lead-covered cable shows that it does not add greatly to the difficulty of insulation. The danger from water and gas is reduced to a minimum by the tightness of the joints of the underground piping, also that all cables deteriorate more or less, whether overhead or placed in the subway, and is not limited to those underground.

3. That the service in Chicago has given a great deal of trouble, and is not satisfactory.

To this the President of the Chicago Arc Light and Power Company replies that in four months only four burns-out underground occurred, a surprisingly small number as compared with that in overhead systems, and that the working was very satisfactory ; in one case fifty or more arc lights are being run on a single circuit of 9 miles, using a cable known as Patterson's, laid underground in a 2-inch iron pipe.

4. That arc light wires cannot be buried with telephone and telegraph wires in the same conduit.

The above objection does not apply, there being no intention of doing so.

5. The pipes forming the duct being in 10 to 20 feet lengths, which are joined together by sleeve couplings screwed up tight, with no compensating device for contraction or expansion ; the result of this must be to bring about the disintegration of the concrete and loosening of the joints in the tubes, thereby allowing the percolation of moisture and noxious gases through the joints, to the detriment and final destruction of the enclosed cables.

The defence says that experience has shown that in the comparatively short lengths of pipe between two manholes no necessity for compensating devices has arisen, and the ends of the pipes not being fixed rigidly to the walls of the manhole, freedom is given for expansion endwise, and that the joints have not been found to work loose ; the distance apart of the manholes is about 60 yards.

Dr. Moses, one of the filers of a hostile affidavit, stated at the Convention of the National Electric Light Association that the Subway Commission has undertaken a great task, and, so far as they have gone, have done it as well as the present state of the art will allow.

The subways have been designed to afford a good and ample mechanical protection for the cables, and the Board considers that the insulation is a matter for the companies using the ducts to deal with, and consequently they must procure and use such cable as will meet the requirement of the electric service for which it is intended.

The "Patterson" cable, manufactured by the Western Electric Manufacturing Company, seems to be looked upon as the most approved electric light cable for underground work ; it consists of a stranded copper wire, cotton wrapped with paraffine insulation, and covered with an alloy of lead and tin. The insulation test gave 400 megohms per mile at the factory and 300 megohms when in the subways, with splices and connections made, the potential generally used underground being 2,250 volts. Experience was showing that improvement could be effected by increasing the thickness of insulation ; originally this was $\frac{3}{32}$ of in inch, now $\frac{6}{32}$, and will possibly be made still greater in the future.

In the City of Boston it was necessary last year to increase conduit facilities by additions to the iron pipe and concrete system belonging to the New England Telephone and Telegraph Company, laid down in 1882. On uncovering a length of 2,269 feet, the concrete was found to be in perfect condition, showing no signs of disintegration, requiring the use of cold chisels to effect its removal. The iron pipe when exposed was sound, with no signs of external rust. There was a slight sign of rust in the inside of the pipe caused, no doubt, by the water of condensation ; there were no indications of loosening of joints owing to the contraction and expansion of the iron tubing. This experience incontestably proves the success and durability of the above method of laying conduits, and that the Board of Control of New York has exercised great care and forethought in planning its scheme for underground distribution

The insulation resistance for any cable placed in the ducts shall be, at the temperature of 75° Fahrenheit, 15 megohms per mile for every 100 volts employed in the circuit. Whenever the insulation falls below 5 megohms per mile, that conductor shall be no longer used unless for a current of proportionately reduced potential, 150 volts to be the minimum E.M.F. used in testing the insulation, which must not be reduced below the 15 megohms by an immersion of at least 60 hours. After the completion of the line in the subway, the above test shall be made daily for a month, and weekly after that time.

C

A fact brought prominently out by the report is the really remarkable, and, to us on this side, astonishing increase of electrical business in the City of New York. The work accomplished during the last twelve months in arc lighting alone has added 200 per cent. to the number of arc lights running a year ago. The public authorities have lighted by electricity many more streets. The telephone and telegraph service has not been without its share of the general augmentation of business.

As far as can be seen the only event likely to interfere with the successful working of the subway would be some unexpected and rapid deterioration of the lead covering to the cables. If, however, the ducts are kept as dry as a careful construction of the conduits should render them, and some means be found to neutralise the effect of the condensation water, whose presence cannot be avoided, there can be no doubt that the confidence placed by the Board of Control in these underground means of distribution will be fully justified.

SIX YEARS' PRACTICAL EXPERIENCE WITH THE EDISON CHEMICAL METER.

By W. J. JENKS.

(*Continued from page* 46.)

FIG. 1 shows plainly the general form and the connections. The counter is operated electrically by the motion of the index of the balance, contacts are made in mercury cups, dash pots regulate the motion, and reversing commutators, operated by hand once a month, keep the transfer of copper from plate to plate from going always in one direction. A simple electrolytic cell is used as a check. This is probably significant of the inventor's lack of faith in mechanical meters, and is particularly interesting to look back upon, in the light of subsequent progress.

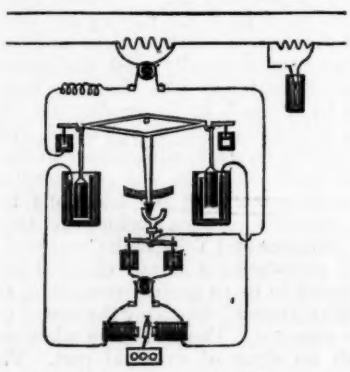


FIG. 1.

Revolving Recording Electrolytic Meter. (Still pending in the Patent Office.) Fig. 2 shows an interesting modification of an integrating electrolytic meter, in which between two electrodes immersed in the electrolyte is placed a wheel or cylinder of the same metal, free to revolve on its axis. It is apparent that if the wheel were perfectly balanced and delicately poised, the passage of a current would alter the balance, and it would revolve at a speed depending almost entirely on the friction of its bearings. But if it were first caused to revolve at a definite rate for one-half a revolution, the lower limb moving in the same direction as the current, there would be a deposit and loss on opposite halves of the disc, causing a variation of position of the centre of gravity around the point of support, causing the revolution to continue at the same rate for the same current, or at a rate proportional to the current. The diagram shows a dial scale for reading fractions of a turn, and an electric counter recording complete revolutions.

Floating Electrolytic Cell. Patent 248,565. Application filed December 15th, 1880. Fig. 3 shows an endiometer intended to decompose water, collect the mixed gases in a bell glass, and when a definite quantity is evolved by the raising of the glass, automatically

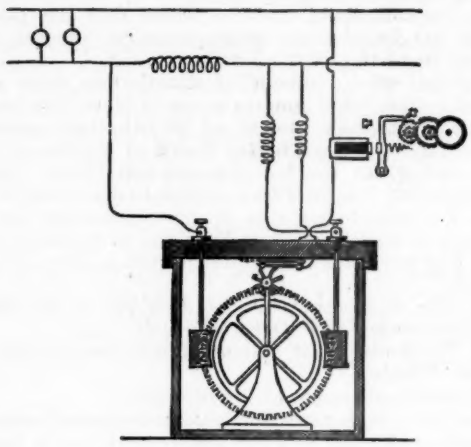


FIG. 2.

cause recomposition, and consequent falling of the glass, by closing a circuit through a platinum coil, which becomes heated thereby. This operation is to be repeated continuously while the current is passing, a counter giving a record of the number of charges of gas exploded. Among the difficulties of using such an apparatus are the comparatively high E.M.F. required, the energy wasted, and possibly, like the nitro-

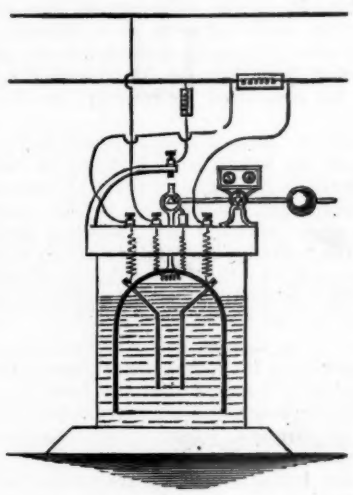


FIG. 3.

glycerine engine, "the necessity of providing a new machine after each explosion." A very similar apparatus has been recently proposed as a laboratory standard for current measurement.

Automatic Temperature Regulator. No. 251,558, filed August 30th, 1881. This patent, illustrated in fig. 4, covers important features of the Edison meter of to-day. Briefly these are:—(1), the resistance, acting as a source of heat to prevent freezing of the liquid in the bottles; (2), the thermostat completing circuit through resistance at the proper degree of temperature; (3), distance pieces for holding electrodes a fixed distance apart.

Fundamental Temperature Regulation Patent. No. 265,774, application filed November 11th, 1881. Fig. 5 illustrates a method of generating heat by the action

of a thermostat energising an electromagnet controlling a valve which, being opened, permits water to flow upon quick lime. This is one of the methods illustrative of the broad idea of "causing a fall in the

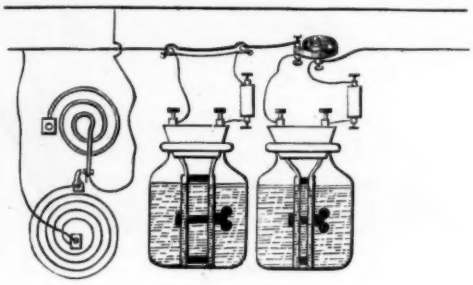


FIG. 4.

temperature to set in action agencies for generating heat" and thus maintaining automatic temperature regulation in an electrolytic cell. Another method here described is the one now practised, the closing of "a circuit to an electric lamp placed in proximity to the

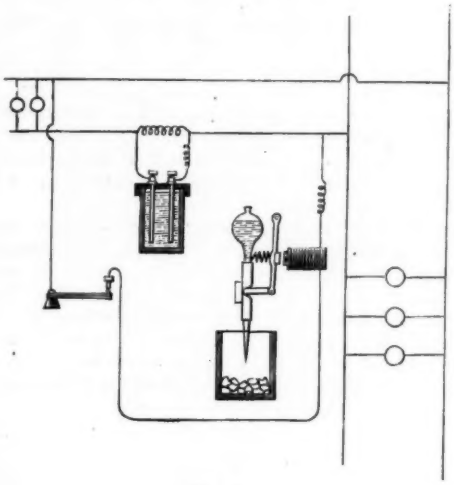


FIG 5.

call." On the same date of this application, Mr. Edison filed Patent No. 281,352, describing one of the most vital features of the practical apparatus, namely, amalgamated zinc electrodes in a solution of

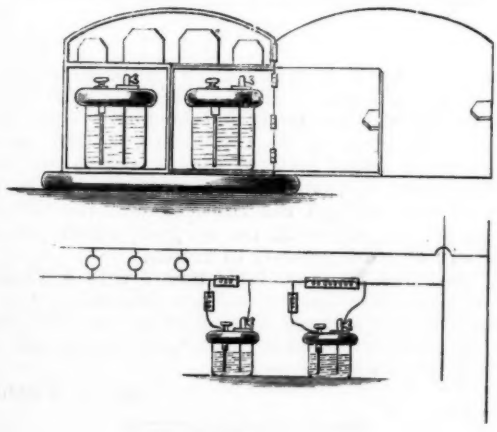


FIG. 6.

sulphate of zinc. This overcame the disadvantages of copper plates which had formerly discouraged the inventor.

Compensating Coils in Electrolytic Meters. No. 251,557, applied for May 27th, 1881. Fig. 6 illustrates certain minor claims of details some of which apply to the Edison meter of to-day, and one feature without which probably no electrolytic meter would be practical, the "compensating spool" having a + temperature coefficient to balance the − coefficient of the bottle resistance. This patent also covers the use of two cells depositing with unequal rapidity. The original plan involves, of course, only a two-wire meter. This was first made with a separate resistance for each bottle, one of them being intended to register a month's consumption, the other three months. It was also proposed that the two compartments have separate keys, the inspector of the three months' bottle thus having a private check on the three readings taken in the same time from the other side. It was soon found preferable to weigh both sets of plates together, particularly as inexperience in the manipulation gave rise to errors against which the duplicate records formed a check of great usefulness. This duplication has been found unnecessary in the smaller sizes.

The student of the meter question may find interesting modifications of these general principles in Patents 240,678, 281,352, and others.

These sketches, and the patents enumerated, convey a faint idea of the months of patient analysis, the multitude of experiments, and the scores of models and drawings which may be found described in Mr. Edison's note-books, many a page written by his own hand years before the electrical fraternity conceived of the importance of these devices for which the world now loudly calls. The electrolytic principle was finally determined upon, the details perfected, and more than six years ago the first devices were placed in the offices and stores of the first customers of the Pearl Street station in this city, the first station in the world to distribute current for incandescent lamps by a comprehensive system of conductors buried underground like gas pipes. The experiments thus made were so exhaustive and thorough in their character, that the meter then designed is substantially the one in use to-day in numerous stations throughout the United States and several stations in foreign countries. The Edison Company has tested every form of direct current meter thus far found in any degreee practicable, without discussing (as vital) the question of economy either in first cost or operation, and has no knowledge of any other form which has been found to be as accurate under all working conditions, and as reliable when submitted to that tribunal before which so many carefully constructed electrical

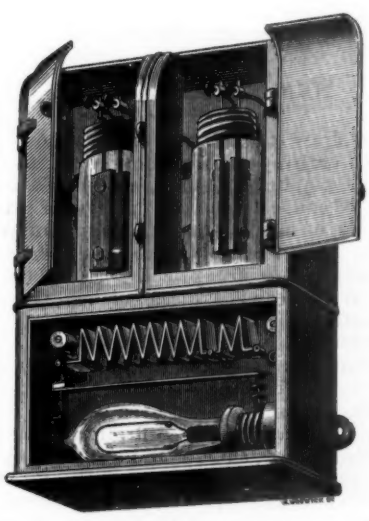


FIG. 7.

devices fail—the test of time. The Edison meter is also cheap, but this is of less vital importance. Hence all other forms appear to be commercially impracticable. Some have inherent defects, caused by variations of permanent magnetism. Some are too large to be of

any value for commercial use, and they are almost, without exception, too costly and delicate for practical service, or too wasteful of the energy they demand for their operation. We have abundant evidence of the justice of these statements when we remember that out of the large number thus proposed, there is not another which has come into anything like extended use. The record which we can quote is therefore the only one from which any conclusions can be drawn as to future practice in this direction. We shall be better prepared to appreciate the results obtained after glancing at the distinctive features of the meter as at present constructed.

Fig. 7 Old Form of Two-wire Meter. This shows the iron case of the form of meter placed at the time of starting the first district station, September 4th, 1882. The division in the G.S. shunt resistance for the long and

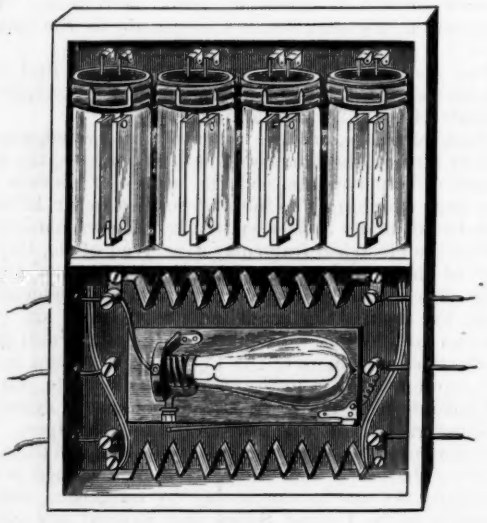


FIG. 8.

short period bottles has given place to a method of connecting both to the same terminals. The flexible connections have been superseded by the spring clips, and in the three-wire meters two shunt resistances are placed as in fig. 8.

(To be continued.)

NEALE'S TELEPHONE.

I WISH to draw your attention to a new telephone working on entirely a new principle to Bell's receiver. There is no diaphragm, but it works with a magnetic core and two coils; the core is made up of several small iron tongues, of which you can have any number. The instrument is then entirely boxed up, and two hearing or receiving tubes are placed to the box, and the different voices can be distinguished through it as plainly as through a Bell receiver.

This instrument works as follows:—

Fig. 1.—N and S represent the north and south poles of three magnets, each of which is divided in the centre, and an adjusting screw fixed to each one. The tongues n^2, n^3, n^4, n^5, and n^6, are fixed firmly in the iron case, E, and the tongue s^1, s^2, s^3, s^4 and s^5, are fixed firmly in the iron case, F. Now between these tongues are placed solid bars of iron, some thick and some thin; for instance, the pieces between the tongues, s^1 and s^2, s^3 and s^4, n^3 and n^4, and n^5 and n^6, are all thin bars, say about $\frac{1}{8}$th or $\frac{3}{16}$th inch thickness, and these bars are placed as below, viz., two to each tongue, and leaving a small vacant space, P, fig. 2, up the centre, to enable the sound to come through from the vibrating of the separate tongues.

The bars between s^2 and s^3, s^4 and s^5, n^2 and n^3, and n^4 and n^5, are thick, say about $\frac{1}{2}$-inch, and there is also a vacant space left there through the centre of the

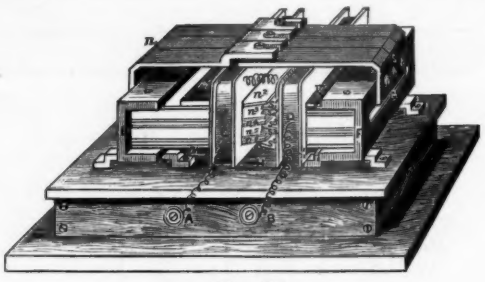


FIG. 1.

tongues to allow the sound to come through the holes, G, in the backs of the iron cases, E and F. These tongues are then all screwed firmly together in each case, because the more firmly they are put together the better they will work. Between the coils, C and D, where the tongues meet, they should have about $\frac{3}{4}$-inch quite *free play* entirely, but the other part of the core should be quite solid and firm. Other plates of iron, m and m^1 and n^1 and n^1, should be placed at the top and bottom of the tongues, and a screw put through each, so as to hold them firmly together, because the more firmly these are made and the better and stronger the iron the better they will work and the more distinct. After this two coils, C and D, are fixed on plates M and M^1, and wound with No. 40 wire and about 120 ohms on each coil. A and B are the two terminals.

The working is as follows:—the magnets n and s induce the magnetism in the tongues, and consequently the poles of the magnet are now removed to between the coils C and D; as they stand now, taking the five tongues, n^2, n^3, n^4, s^1 and s^2, n^2 attracts s^1, but s^2 drives s^1 away, they both being the same poles of a magnet, therefore there are two forces acting on s^1: it is the same with s^2, s^2 is attracted by the opposite

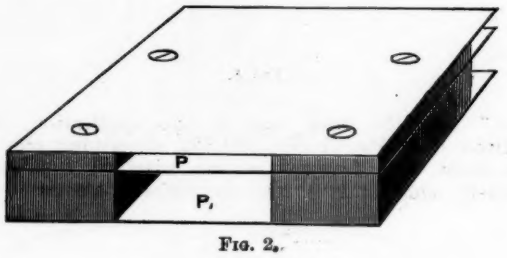


FIG. 2.

magnet, n^3, but s^2 is driven away by the same magnet, s^1, and it is the same with all the tongues, each one has two powers working on it, and no matter how many tongues you place in the instrument, you still get the same forces acting on each tongue, and as your magnetism increases or decreases, according to the current that is sent through the coils, so will the different forces act on your different tongues, which you will find will all work together in unison.

I tried one of these instruments with a Crossley transmitter, and found it worked remarkably well. I made my tongues from a sheet of rather thick tin—No. 21 Birm. wire guage; if thinner sheets are used they will not work so well.

FRED. W. NEALE.

The Institute of Medical Electricity.—This institute has recently received pleasing testimony to the fact that it is doing good work, in the shape of a present of 10 guineas' worth of books for the reference library, which a patient has presented as a mark of his gratitude for benefits and attention received at the institute.

WARD'S ELECTRICALLY-PROPELLED OMNIBUS.

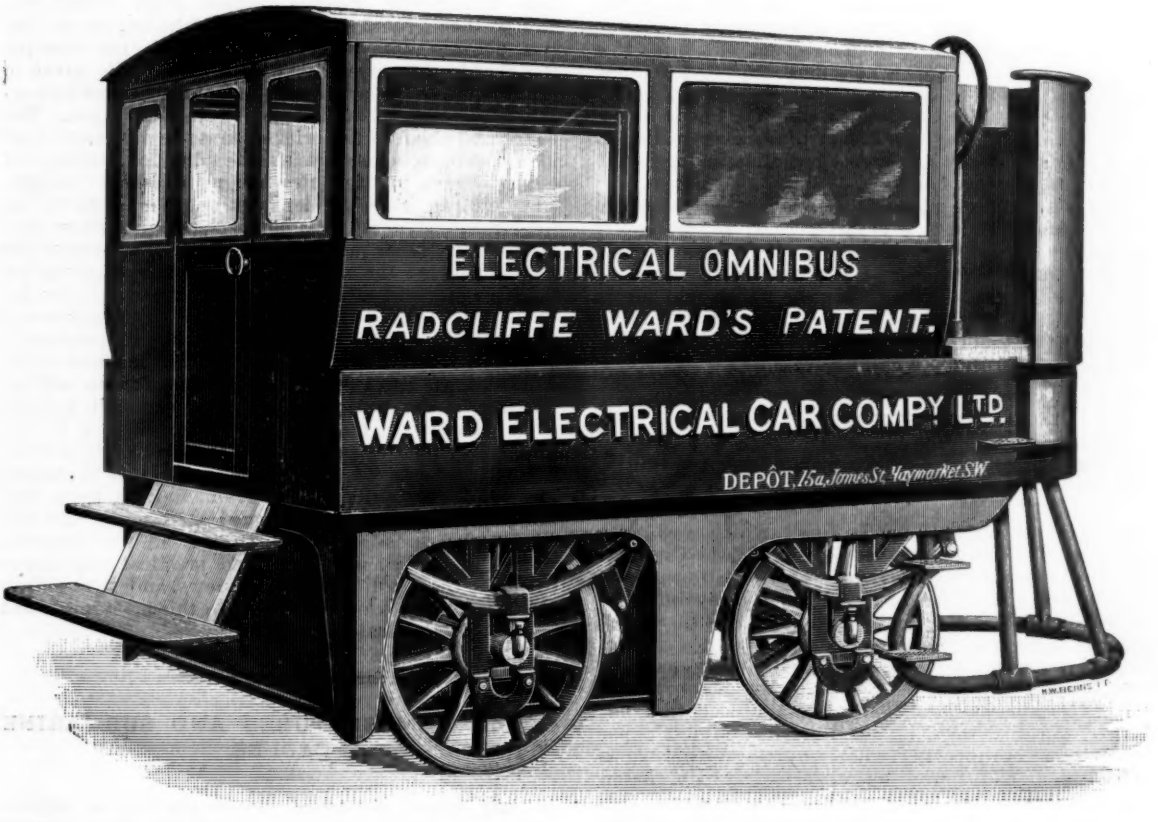
WE illustrate in this issue the first electrical omnibus ever constructed. It is the invention of Mr. Radcliffe Ward, of the Ward Electrical Car Company, Limited. The attention of the inventor was drawn to the question of working vehicles by electricity many years ago, he having assisted in the first experiments on electric power transmission which were ever made on a practical scale in this country, viz., those by Captain Blanch Brain, Trafalgar Collieries, Forest of Dean, Gloucestershire. Early in 1882 he carried out experiments with the first electrical tramcar ever operated in England on the North Metropolitan tramways at Leytonstone, to demonstrate the fact that accumulators could be applied for vehicular purposes. Some little time after this he started the construction of a car to run over the ordinary streets, but postponed it, mainly on account of the difficulty of obtaining well constructed accumulators at that date. In 1887 he carried out experiments with an electric cab built from his designs. In the summer of 1888 this omnibus commenced to make runs over the London streets, and with it the data has been obtained from which electrical vehicles of various descriptions can be constructed to accomplish any given result.

The pith of the whole question is, of course, how much cheaper than horse traction is electricity? The cost at which electricity can be delivered from a generating station is well known, and many firms of repute are prepared to erect stations to produce electricity at a very low cost.

The second item is the question of the depreciation of the various appliances used on electrical vehicles. This is also on a perfectly clear basis, as many firms of well-known standing are prepared to guarantee that the depreciation of their plant shall not exceed a certain figure. What was not shown, however, and what the inventor had to find out, was how much electric energy was actually required to carry a certain weight over the ordinary streets, and this has been done with the particular vehicle in question. The cost per mile, therefore, at which various kinds of vehicles carrying certain weights can be operated over the ordinary streets and roads is definitely known, and does not rest on any problematical basis. There is no doubt that such an important question as the working of large numbers of vehicles in all towns will cause an immense impetus to the electrical industry, and will benefit all concerned in it.

Should Mr. Ward's very sanguine anticipations be realised there will be opened up a new source of profit to electric generating stations. The dividends obtainable from electric lighting centres will undergo a total change when there is the possibility of supplying large quantities of electricity during non-lighting hours for the purpose of operating vehicles, and all those possessing dynamos will find a new source of profit.

The Ward Electrical Car Company is at the present moment discussing the question of electrically-propelled vehicles on a large scale with several of the most important railway companies; as, however great the economy may be for omnibuses, it must be very much greater for vehicles, such as goods and parcels vans which stand about during such a large proportion of the time they are out. The same applies to cabs. The company also is going into the question of operating dust-carts and such vehicles. This alone is an enormous business. They are also considering the question of establishing lines of omnibuses in combination with the existing proprietors of omnibuses or otherwise, also that of establishing electrically-propelled cars.



The vehicle which we illustrate is not intended to represent the future type of omnibus, but was constructed for the purpose of obtaining data and making investigations. It has been equipped with E.P.S. traction cells; the first set of cells of the present type which the Electrical Power Storage Company ever manufactured. The Ward Company is satisfied that when the Electrical Power Storage Company is prepared to guarantee the depreciation under proper conditions, that it would be perfectly safe in accepting a

contract to that effect. The car was equipped with Gramme motors, manufactured by R. E. Crompton and Co., and the motors proved to be thoroughly reliable and efficient machines. The inventor has experimented with traction gearing, belts, toothed wheels, chained wheels, &c., and finds one form good for one purpose another for another. Steel chains are used on the omnibus shown, manufactured by Mr. Hans Renold, of Manchester, and these also have proved themselves thoroughly reliable and efficient power transmitters. The frame work of the omnibus was constructed at the works of the Metropolitan Railway Carriage and Wagon Company, Limited, Saltley. The wheels, which are of special type, were constructed from the designs of the inventor.

The Ward Electrical Car Company, Limited, does not, at the present moment, intend unless there are some special inducements to the contrary, going into the manufacture of electrical appliances. The directors propose rather to avail themselves of the existing electrical manufacturers. They are able at the present moment to make contracts for several different types of accumulators, which will give satisfactory commercial results for street vehicle purposes, and of course the company has the choice of many types of motors made by different people.

Mr. Radcliffe Ward undertook, and has handed over to the Ward Company, the first contract ever made for an electric goods cart; it is now building, and the trial trip will take place shortly.

It will readily be understood that in a new branch of work such as this, many special devices and appliances have proved to be necessary for the commercial carrying out of the work, and the Ward Company considers that it possesses many patents which will prove of commercial importance in the affair. At the same time, it is felt that the enterprise tends to the prosperity of all concerned in electric industry.

DESIGNING ELECTRO-MOTORS.

THE paper of Mr. Albion T. Snell, which was read before the Old Students' Association of the City and Guilds of London Institute, is full of interesting points, and it agrees with the views we have on several occasions expressed: that within certain limits there is a decided difference between a dynamo and a motor. That these views are not shared by every electrical engineer is a well-known fact, and Mr. Esson, whose vast experience will always command attention, has opened the discussion on Mr. Snell's admirable paper by strenuously opposing what we always regarded as a fact, and had found by experience. Mr. Esson based his assertions upon certain experiments with dynamos driven as motors, and he came to the conclusion that "it makes no difference to the E.M.F. whether the armature is belt driven or current driven, provided the fields are in each case the same."

Some years ago we made some experiments with a Burgin dynamo constructed in 1882, and the following figures resulted from the employment of the machine as a generator and motor respectively;—

	Speed.	Ampères.	Volts.	
Motor ...	1,076	17·8	116·2	Speed and current
Generator	1,086	17·8	84·5	practically constant.
Motor ...	728	19·4	83·5	Current and E.M.F.
Generator	1,100	19·0	85·1	practically constant.

These figures are very interesting, but different types of machines will give various results, and Mr. Esson may be correct so far as his experience goes.

Mr. Snell's paper refers to the design of motors adaptable to circumstances where weight and dimensions, as well as efficiency, enter into the calculations, and he endeavoured to show that a good motor need not be a good dynamo, although all good continuous current dynamos will also work efficiently as motors. All the best modern motors have been developed out of one type or another of dynamo, and we feel certain that motor makers do employ a different design of machine on a tramcar to that at a generating station. But apart from questions of utility and convenience, there is a decided difference in the reactions between the armature and field magnets of a dynamo when driven as a generator or as a motor.

Professor Sylvanus Thompson illustrates this point lucidly in his book on dynamo-electric machinery. In the case of a generator, the current induced in the armature coils tends to magnetise the armature core in a direction nearly at right angles to the direction in which the field magnets magnetise it, and in consequence there is a resultant magnetisation at an oblique angle. This obliquity necessitates a certain angular lead to be given to the brushes in the sense of rotation; and the necessary result of the forward lead of the brushes is to cause the polarity of the armature to tend partially to demagnetise the field magnets. In a motor this is not so. A current supplied from an external source magnetises the armature, and makes it into a powerful magnet, whose poles would lie, as in the dynamo, nearly at right angles to the line joining the pole pieces, were it not for the fact that in this case also a lead has to be given to the brushes. The armature's magnetism reacts now on the field magnets adding to its lines of force. The lead to be given to the brushes must be a forward lead if the proper advantage is to be taken of the mutual strengthening of the two magnetic forces. Again, since the armature's polarity strengthens that of the field magnets it is possible for a motor to be worked without any other means being taken to magnetise the field magnets; the armature will induce a pole in the field magnet and attract itself round toward this induced pole. Mr. Reckenzaun proved this experimentally several years ago, and Mr. Snell practically confims it. Mr. Mordey pointed out in the pages of the ELECTRICAL REVIEW that in a generator the self-induction in the sections of the armature coil, and the eddy currents in the core, are antagonistic; in the motor they tend to increase one another. Mr. Albion T. Snell deserves the thanks of all interested in electric motors for reopening this question, and we hope that the paper will, at the adjourned meeting of the Old Students' Association, be discussed on the broadest lines, and that all who have had practical experience in this subject will give their views, and thus add to the common stock of knowledge in this most important branch of electrical engineering.

OCEAN TEMPERATURES AND SUBMARINE CABLES.

IT may appear somewhat late in the day to refer to the very interesting paper on "Ocean temperatures and submarine cables," read before the Society of Telegraph-Engineers and Electricians by Mr. Lant Carpenter; but we have deferred any expression of opinion, or criticism of the paper, in the hope that some one among our readers would have called attention to the fact that the paper referred to hardly fulfilled, in a certain direction, the expectations of many present. While undoubtedly of great merit, the essay diverged considerably from the line we anticipated it would follow, and instead of presenting the meeting with a complete exposition of the title subject, an account was given of bottom temperatures, at various depths, in different portions of the globe, quite irrespective of their relationship to submarine cables. We have therefore considered it not altogether inopportune to venture a few remarks upon the point omitted, that is, the correction to be applied to dielectric resistance in the case of a cable lying in very varying depths and temperatures, where there will be present very varying conditions of resistance. These conditions imply the necessity of correcting the observed dielectric resistance, not by a mean temperature and a

mean pressure, but by a division of the cable into sections, to each of which must be applied the correction corresponding to its depth and temperature. This question, although of course well-known to all submarine telegraph-engineers, has not, to our knowledge at least, been treated of before the society or in any scientific publication, and we must confess to having been disappointed that such an important element should have been neglected in the orginal paper, and ignored in the subsequent correspondence.

The very value of these bottom temperatures, so far as regards submarine cables, lies in the possibility afforded by them of applying an accurate temperature and pressure correction to every portion of a cable. It can be readily appreciated how inaccurate must be corrections based upon a mean temperature calculated from the conductor resistance of the whole circuit, and a mean depth which may actually vary every few miles, and may have a range of from 100 to 2,000 fathoms; it is no less easily understood that every portion of a cable where a change of depth occurs requires a separate reduction. The selection of lengths corresponding to different depths and temperatures must, of course, be by inspection and may be considered somewhat arbitrary, but a cable route which has been carefully sounded over presents no difficulty to a correct determination.

The object of such careful comparison is naturally to compare the condition of a cable after being submerged with the standard tests in the factory at 75° Fahr., eliminating the increased resistance and apparent improvement in the percha, due to pressure and low temperature.

Theoretically speaking, the comparison should be made with the true 75° of the cable on board ship immediately previous to laying, and a coefficient table constructed upon the lines then indicated, for the gutta-percha since its manufacture has undergone a series of very material changes, so that the coefficient tables should, strictly speaking, be very different to those in use at the time when the core was still fresh. But we are aware of no practical method of obtaining these figures, so we must rely upon the tables constructed from factory tests. A more correct approximation could certainly be attained by forming coefficient tables from experiments on one exactly similar to that used in the cable, constructing different tables for different ages of core.

The coefficients used for the reduction of dielectric resistance do not progress arithmetically, but follow the laws of compound interest. If, therefore, we take a mean temperature for the whole of a circuit which happens to lie in considerable variations of depth, in neglecting the effect of the differences in temperature due to these variations, we fall into a serious error, immensely aggravated by the construction of the coefficient tables, whenever any divergence from a mean temperature line occurs.

The necessity of a "step-by-step" correction does not, of course, apply to the case of a cable lying on a level bed with but small portions at the extremities in varying depths. Under such conditions the mean temperature as calculated from the conductor resistance of the whole circuit is sufficiently accurate for practical work.

THE CANADIAN PACIFIC TELEGRAPH SYSTEM.

MR. CHARLES R. HOSMER has every reason to be proud of the wonderful telegraphic system which accompanies the Canadian Pacific Railway throughout the length and breadth of Canada; and in the new issue of that cheerful annual, "Puck's Girdle; or. Gleanings from the Postal and Telegraphic World," he recounts some of the leading features of his charge. Upon the completion of Canada's trans-continental railway every recent writer upon the progress of the Dominion dwells with well-grounded satisfaction, but how few realise the revolution which the Canadian Pacific telegraphic system has been working in the commercial life of all parts of Canada during the past few years? In former days the Great North-Western Telegraph Company had undisputed control of the entire telegraphic business of Canada; and so great was the power it exercised for good or for evil that people began to seriously ask themselves whether such exclusive power should not belong alone to the Government, and be subject to popular control. As was the case, however, with English railways, so it was with the Canadian telegraph system: relief from the danger was speedily found in competition. The engineers who carried the railway line across the continent also took with them the essential telegraph line, until in November, 1885, Canada found that she possessed not only a great trunk railway, but also a telegraph system bringing every section of the Dominion into the closest contact, and occupying the almost unique position of being practically operated as a portion of the Canadian Pacific Railway system.

But in its anxiety to beat record in the matter of distance, Mr. Hosmer shows that the Canadian Pacific Company has not forgotten the need for a high-class telegraphic service. This care in establishing an efficient line was made all the more necessary by the enormous lengths of the circuits which have to be worked. Mr. Hosmer tell us that direct circuits (duplexed) are worked regularly between San Francisco and New Westminster, 1,200 miles; between New Westminster and Winnipeg, 1,472 miles; and Winnipeg and Montreal, 1,423 miles; while, after six o'clock, Winnipeg and New York work direct with each other over a distance of nearly 2,000 miles, and on Sundays New York and San Francisco are put in direct connection over a distance of over 4,600 miles. And this is not all, for Mr. Hosmer, speaking of that beehive of industry, his central office in Montreal, says:—

> In the operating room of the company at Montreal, which is its head office, can be seen telegrams passing to and fro between San Francisco and New York, Chicago, &c.; and also messages going back and forth between San Francisco, Vancouver, British Columbia, and other Pacific points, and China, Japan, Australia, New Zealand, Batavia, &c. Let us presume that one of the regular steamers of the Canadian Pacific Railway has just sailed from Vancouver to Yokohama, a distance of 4,232 miles, which she makes in from 12 to 14 days. The telegram announcing her departure to the agents in Yokohama would go *vid* Montreal to New York, 3,500 miles; thence across the Atlantic to England, 3,000 miles; England *vid* Gibraltar, Malta, Alexandria, Aden, Bombay, Madras, Singapore, to Hong Kong, 8,500 miles, and to Yokohama, 1,600 miles, or a total distance from Vancouver to Yokohama of 16,600 miles—that is, nearly four times the distance covered by the steamer.

This reminds one of an incident in last year's great snow storm at New York, when the merchants of Boston were so cut off from telegraphic communication with the American metropolis that prices on the New York Exchange had first to come across the Atlantic from New York to London, and then back again from London to Boston—a circuit of some 6,000 miles to connect cities not much more than 200 miles apart. Of course Mr. Hosmer, like the rest of us, confidently looks forward to the time when Vancouver and Hong Kong and Yokohama, as well as Australasia, will be connected by direct cable, and then, as he puts it, the operating room in Montreal will witness the business of half a continent reversed and set travelling in a direction in which Old Father Time, even though, as the proverbs says, he waits for no man, will be beaten in his own race, at least over half a hemisphere, and telegrams will reach Vancouver eight hours ahead of the time they leave London. When that feat is accomplished—and accomplished it soon will be, if the Mother Country does one-hundredth part of what Canada has done on her own initiative—Canadians will remember with pride that it was the enterprise of their own citizens that enabled them to furnish an important link in the chain that completes a girdle round the earth.—*Canadian Gazette.*

NOTES.

The French Press and the Electric Light.—Commenting upon the electric lighting of Paris, of which we have given full particulars in the last two numbers of the ELECTRICAL REVIEW, our Parisian contemporary, *Le Soleil*, says:—"However rigorous the conditions imposed by the Municipal Council, their acceptance by several electric light companies permits of their being considered as compatible with profitable working. The concessionaire companies have not, however, accepted the prescriptions of the Council with a very good grace. In a letter dated February 17th, 1888, they called the attention of the third commission to certain clauses which they did not think it possible for them to accept. If they obtained certain modifications demanded by them, others were absolutely refused. As they have been voted, the prices guarantee the interests of the city, but they show once more the tendency of the Municipal Council to meddle with things for which it is not competent, and to substitute itself for the Administration in things even where its meddling is the least to be justified. It is known to what a point this assembly knows how to lose the time it disposes of in its discussions, which are often as confused as they are useless. It is also known that were they even endowed with high capacities and with incomparable application—which is not the case with the majority of our ediles—they are still strange to technical electrical questions, which is nothing astonishing, the usual applications of electricity being of a very recent date. Well, this assembly, which has neither the time nor the special competence it should have, has almost wholly reserved to itself the control and direction of the new lighting, which it would, however, appear more natural to leave to the Administration responsible before it. It is the Council which will intervene for bringing about the revision of the maximum tariffs fixed. It must take the opinion of a technical commission, composed of two delegates nominated by itself, and of two nominated by the concessionaire; but if the opinion be not pleasing to it, it will pass it by without noticing it. It is also the Council which will have to decide if the footways are large enough to allow of the placing underneath them of the electric conductors; it will also have the approving of the plans and conditions of the establishing of the pipes before the conductors are placed therein; and it is yet again to it that the concessionaires will have to address themselves when they want to make any alteration in this canalisation. Lastly, faithful to one of its most cherished follies, the Council has not failed to prescribe prices for the work. It has done even better; the series of city prices contain no regulations on the salaries paid to workmen special to the electrical industry, and it has in advance fixed the minimum tariffs for the different hours of the day. It is in vain that the Senate and the public powers have on several occasions declared that this pretension of the Council is absolutely inadmissible and valueless; the Council holds to it, and the non-execution of this clause may give rise to difficulties of all kinds in the way of still retarding the electric lighting of Paris, which, however, is so desirable."

The Electric Lighting of Newcastle.—A meeting of the sub-committee of the Newcastle Town Improvement Committee was held last week to consider the applications made, one by Messrs. Leadbitter & Harvey, and the other by Messrs. Watson & Denby, on behalf of two separate companies for the concurrence of the committee in their applying to the Board of Trade for powers to supply the electric light in Newcastle. Representatives from the respective promoters were present, who explained what it was intended to do. The feeling of the committee was favourable to the consent of the Corporation being given, as long as there was no monopoly created, and provided the wires were placed underground. The matter will be further considered at a special meeting.

Chelsea and the Electric Light.—At the last meeting of the Chelsea Vestry, the Electric Lighting Committee recommended that the Vestry should dissent from the granting of a proposed provisional order to the London Electric Supply Corporation. This recommendation was adopted, as also was another, that some memorialists be informed that the jurisdiction of the Vestry in the matter of overhead wires is limited in extent, difficult of application, and doubtful in its effects, and that the Vestry was not prepared to initiate litigation against the owners of the overhead wires.

Electric Lighting and the New Thames Ferry.—The enormous ferry boats which have been constructed for the new ferry service across the Thames from Greenwich to the Isle of Dogs are being fitted with electrical apparatus for lighting them both on deck and below throughout. The boats are 44 feet wide and 120 feet long, and are designed to transport passengers, horses, and other animals, and vehicles of all sorts and sizes, including even tram cars and railway carriages.

Proposed Electric Lighting of the Victoria Art Galleries, Manchester.—A well-attended meeting of the Building Committee of the Victoria Art Galleries was held recently for the purpose of considering a report as to the best means of lighting the new galleries and the whole Albert Institute with the electric light. The report was drawn up by Mr. W. A. Bryson. Treating the Albert Institute as a whole—museum, picture gallery, both libraries, and the new galleries—Mr. Bryson proposed a complete scheme, embracing arc lamps for the larger galleries and halls, and incandescent lamps for the smaller rooms, the initial cost of which, including everything—engines, dynamos, wires, lamps, &c.—would amount to £2,800, the annual working expenses to £180, and the annual cost of plant, including depreciation, to £443—or, altogether, £623 per annum—all these, however, being very full estimates, more likely to be lessened than exceeded. It was stated to the meeting that the cost of gas for a year for the whole Albert Institute, including the amount consumed in the new galleries during the three or four months of our annual exhibition would be fully £300. After careful consideration the question was remitted to a special sub-committee, with instructions to go minutely into the estimates, with the assistance of professional opinion, and to report to a future meeting.

Holborn and the Electric Light.—At the last meeting of the Holborn District Board of Works, the Committee of Works reported that they had received applications from the London Electric Supply Corporation and the Metropolitan Electric Supply Company for the assent of the Board to the company's application for provisional orders. The committee further reported that they had directed the clerk to convene a meeting for Monday, February 18th, to consider the applications of the two companies. The report was adopted.

The Grosvenor Gallery.—At a meeting of the St. George's (Hanover Square) Vestry last week, a memorial was read from some ratepayers in New Bond Street, complaining of the annoyance caused by the electric lighting works of the Grosvenor Gallery Company. The memorial was referred to committee for consideration and report.

Swansea and the Electric Light.—In our note of last week the opinion which, by an error, appeared to come from us editorially, should have been credited to a South Wales contemporary. In the present stage of proceedings we imagine that competition for the extension of the lighting of the Swansea Harbour would be undesirable, especially as the Anglo-American Brush Corporation appears to have met the Swansea Harbour in the spirit of the utmost fairness.

Shoreditch and the Electric Light.—At the last meeting of the Shoreditch Vestry, the Parliamentary Committee recommended, for a number of reasons,—amongst them being that overhead wires charged with electricity for lighting purposes would be a source of great danger, and they were of opinion that no legislative sanction should be given to any scheme which included such a system—that the Board of Trade be memorialised not to consent to the present application by the London Electric Supply Corporation for a Provisional Order to lay down mains for the public and private lighting of the parish. The report was adopted.

St. James's and the Electric Light.—At a meeting of the St. James's Vestry on Wednesday last week, the vestry assented to the introduction of the Metropolitan Electric Supply Company's Bill to authorise the company to supply electricity in the parishes of St. James's (Westminster) and St. Martins-in-the-Fields, on the terms and conditions agreed to last year. It was decided to offer no opposition to the draft Provisional Order of the London Electric Supply Corporation, on condition of certain amendments being made in the same. The amendments proposed were of a stringent character, and included the company undertaking to satisfy the Board of Trade that they were in a position to carry out obligations before beginning operations; not to associate themselves with any other company without the consent of the vestry, and to remove all overhead wires, supports, &c., on notices to that effect from the vestry, under penalty; and that the plans for the generating station and proposed buildings should be submitted to and approved by the London County Council. The Lighting Committee recommended "That the Board of Trade be invited to specially consider the proposal of the London Electric Supply Corporation to take powers to lay trunk mains in the district without coming under any obligation to supply electricity therefrom in such district; and also the proposal of the Corporation to take powers to supply electricity to local authorities for the latter to retail to consumers." The recommendation was adopted.

Newington and the Electric Light.—At a meeting of the Newington Vestry on Wednesday last week, the Works and Sanitary Committee recommended: "That the application of the House-to-House Electric Light Supply Company, Limited, for the consent of the Vestry to enable them to apply to the Board of Trade for a provisional order be not entertained; but that no objection be offered to the draft provisional order lodged with the Board of Trade by the London Electric Supply Corporation, nor any action taken to watch the progress of the order through Parliament." The recommendation was adopted.

Yet another Failure at Barnet.—The *Evening News* of yesterday states that on the previous evening Barnet was again in darkness owing to some breakdown or failure in the arrangements for lighting the streets by electricity. The occasion of the failure was peculiarly unfortunate, for Wednesday is the weekly cattle and general market day at Barnet, and consequently there is a good deal of traffic in the early hours of the evening. Again, a thick fog prevailed on Wednesday evening, and rendered efficient street lighting doubly necessary. There have been three previous breakdowns of the kind since the new system of lighting was installed some four months back, and in consequence of these, together with numerous complaints of general inefficiency, the Local Board, some time since, passed a resolution to give the contractor notice to remedy the defects within 14 days. The cause of the new light was, however, warmly and persistently championed by one or two of the members, and with a view of giving the so-called "improvement" a fair trial, the resolution was rescinded. The light was not available at all up to a late hour, and the inconvenience resulting was very great.

The Electrical Omnibus.—On Thursday morning the electrical omnibus, which is fully described on another page, was taken by Mr. Radcliffe Ward and our representative through some of the busiest streets of the metropolis, and fully demonstrated, in the course of an hour's run, that his method of applying electrical power to the propulsion of heavy vehicles in towns is not only practicable, but that, as compared with the employment of horses, it offers some decided advantages. Starting from the depôt at the Haymarket, the omnibus was taken by Charing Cross along the Embankment, through Queen Victoria Street, Cheapside, Newgate Street, Holborn Viaduct, Hatton Garden, Leather Lane, Theobald's Road, across Oxford Street, and by Shaftesbury Avenue, back to the depôt. The trial was thoroughly successful, and the steering gear was put to a severe test at several points; for instance, in Leather Lane, where the 'bus had to be kept clear of the stock-in-trade of the costermongers, who were taking up their positions along each side of this narrow throughfare, leaving very little free passage. The substitution of this system of traction for horses could scarcely fail to be both an improvement and an economy, in the case not only of omnibuses, but still more of delivery and collecting vans, which are for a considerable part of their time stationary, and the question is one well worth the careful consideration of the railway and carrying companies.

Worcester and the Telephone.—A public meeting was held at Worcester last week for promoting the proposal to establish a telephonic exchange in the town. The Mayor presided, and Mr. G. Reakes, district superintendent of the Western Counties and South Wales Telephone Company, made an explanatory address to the meeting. Several promises of support were given.

Fast Speed Telegraphy.—On making enquiries at the Post Office Telegraph Department, St. Martin's-le-Grand, information was obtained to the effect that 600 words per minute were recorded there on Monday, January 21st, by means of the Wheatstone automatic telegraph apparatus.

Secondary Generator Litigation.—The appeal in the action *re* Gaulard & Gibbs patent has been proceeding for nearly a fortnight. It will be remembered that Mr. Justice Kekewich, about a year ago, gave judgment, on the application of S. Z. de Ferranti, for the revocation of letters patent, No. 4,362, of 1882, granted to Lucien Gaulard and John Dixon Gibbs, for "a new system of distributing electricity for the production of light and power" by means of secondary generators. Messrs. Gaulard & Gibbs appealed, and Mr. Aston, Q.C. and Mr. J. C. Graham have appeared in support of the appeal; Sir Horace Davey, Q.C., Mr. Moulton, Q.C., and Mr. L. E. Pyke appearing for the respondent.

An Edison Consolidation.—Articles of incorporation have been filed at Newark, N.J., of the Edison General Electric Company, with a capital of $12,000,000, in 120,000 shares of $100 each. This company is to take over the Edison Machine Works, the Edison Lamp Company, and the big factory of Bergmann & Co., thus consolidating a number of Edison companies into one corporation. It is understood that new factory facilities are to be provided at West Orange, N.J. It is surmised that the object of the amalgamation is to provide additional capital in order to carry out a more enterprising policy in regard to the occupation of new territory.

Swinburne's "Practical Electrical Measurement."—A long and appreciative notice of Mr. J. Swinburne's "Practical Electrical Measurement" (the collected articles upon the subject published in the ELECTRICAL REVIEW) has appeared in the New York *Electrical World.*

The Value of Divided Mains. — M. D. Monnier, of the Imperial and Continental Gas Association, Vienna, whose name figured not long ago in our pages as having given an eminently favourable report upon D'Humy's water battery, was requested to give his professional opinion upon Gordon's divided mains. He thinks with the inventor that their use offers great advantages, but he does not state when or how. There is, however, just one delicious little item in M. Monnier's report which does credit to his unsophisticated nature. Says that eminent authority on electrotechnics :—"The mere fact that Mr. Gordon's divided main consists of a number of small conductors, each separately insulated to a high degree, *ensures the perfect insulation of the whole.*" Did poor M. Monnier never hear of the softening of the insulation in one of the circuits of the Paddington installation, and the mixing up of conductors and insulating material in one conglomerate mass? Sir Daniel Gooch could probably give as good a report upon this "system" as anybody in the world.

Verbum Sap.—We thought a word to the wise at the People's Palace would be sufficient. But it seems this is not so. In the REVIEW for December 7th last we drew attention to the fact that the *Palace Journal* was publishing an advertisement of a quack electro-medical appliance. We hoped that the result of this notification would be the discontinuance of the advertisement; but apparently it has only led to its extension, for in the *Journal* of January 16th, which lies before us, a whole page is devoted to a nauseous laudation of the wares and the methods of a person whom we have endeavoured to expose as a pretender in the domain of medical electricity, and whose much-vaunted "electropathic" belt we have shown to have little or no claim to the title of electric. We cannot suppose that the editor of the *Palace Journal* is knowingly encouraging the sale of worthless appliances by inserting this advertisement; but whether conscious or not of the harm he is doing, he is contributing to the prostitution of an otherwise excellent and no doubt much esteemed publication.

New Premises for Elwell-Parker. — The Elwell-Parker Company has determined to erect new and extensive works on land adjoining the Bushbury Station of the London and North-Western Railway Company at Wolverhampton. The existing works are inadequate to the rapid growth of the company's business, and it has therefore been decided to provide more commodious works, for which designs, &c., are to be prepared by Mr. G. H. Stanger, C.E.

Woodhouse and Rawson Employés.—The annual dinner of the staff and *employés* of the Woodhouse and Rawson Electric Manufacturing Company took place the other evening at the Hotel Olympia, Kensington. There were about 50 diners, Mr. S. Rawson occupying the chair, and Mr. C. E. Lowndes the vice-chair. "The Firm," "The City Office," "The Manager," and "The Foremen," were among the toasts of the evening. The music was good, and the whole proceedings were highly pleasant.

Electricity and Atlantic Liners. — The two new monster Atlantic liners for the White Star Line—the longest vessels afloat, each being 582 feet in length—will be lavishly fitted thoughout with electric light, electric bells, electrical gear in connection with steering and signalling, electric search lights and other electrical appliances of the most approved description.

An Electric Railway in Dublin.—For some time past workmen have been busily engaged in laying down a two-feet gauge line of railway from the stores of the Dublin Whiskey Distillery Company, Richmond Road, to their bonded warehouses on Distillery Road. The line is being constructed by Mr. Berry, of Manchester, and will be ready for work in a short time.

Lapsus Memoriæ. — Captain James, the candidate in Kensington for a seat on the County Council, who, as we mentioned at the time, put forward electric lighting as a plank in his platform, has beeh elected with *éclat.* As we observed, he forgot or did not know that the County Councils will have nothing to do with lighting, but the success of this gentleman for a district where the electric light is being pushed may be of good augury. Mr. Lindsay, who is related to Lord Crawford (himself an authority on electrical science) and who was almost the only member of the Vestry who understood the question of electric lighting during the recent controversy, was unfortunately defeated.

Notes from Demerara.—The West India and Panama cable was broken down for about a week in October, some 11 miles of new cable having to be cut in by the ss. *Duchess of Marlborough.* The repair was a piece of smart work. In December the same cable was again damaged, and for a fortnight Demerara was telegraphically cut off from the outer world, though the smartness of the company's agents at Demerara and Barbadoes, in hiring fast sailing sloops, reduced the loss to two or three days. The *Duchess* having been severely damaged in a collision at Trinidad, the *Grappler* had to go in search of the fault. The *Royal Gazette* (Demerara) of Thursday, January 3rd, contained the following :—"In our last issue we announced the arrival in the colony of the new telephone intended for the telephones exchange. We have now, however, to intimate that this institution has ceased to exist. Some time ago a number of the subscribers sent in notice to the Government to the effect that in the event of there being no improvement in the service before December 31st it was their intention to cease their connection with the exchange, and accordingly the subscribers yesterday requested their names to be removed from the list. This we understand has been done, and, as a matter of fact, at the present moment only the Government offices are in telephonic connection. The collapse of the telephone exchange is to be regretted, and the more so seeing that the new instruments have arrived. At the same time, it should not be forgotten that from the very outset it was predicted that the Ader Telephone would never suit the requirements of an exchange system in this colony." From this it will be seen that the telephone exchange at Georgetown, as it existed, is no more. The merchants, first of all, laid down an impossible condition without considering its practicability. There is a fine irony in the fact that the very morning Mr. Vyle cut the connections in the exchange he also had the pleasure of inspecting the new switchboard and the very carefully finished Bell and Blake apparatus then to hand. The wires leading to the Government offices are being carefully overhauled and dry joints replaced by well soldered ones, prior to placing new telephones thereon. An entirely new route is planned, to start from a new exchange, and No. 14 copper wire will replace No. 16 iron, and no dry joints will be permitted. Then, it is proposed to keep open day and night, and to work during the day with female operators. It is also whispered that such a reduction will be made in the rates as to give Demerara the unique position of being worked at the lowest rates known anwhere. That, coupled with the efficiency we are sure will be attained, will do away for ever with the oft repeated taunt of what can be done in Barbadoes. A month or two will necessarily elapse before Mr. Vyle gets his wires erected, and the public telephone exchange once more working in Demerara.

Old Students' Association.—The discussion on Mr. Albion T. Snell's paper will be resumed on Wednesday, January 30th, at 7.45 p.m., at the Central Institution, Exhibition Road, S.W. In regard to the Employment Register Mr. Adams will be glad to hear from any members seeking appointments and also from those who may be requiring assistants or are in a position to know of vacancies.

Twist Drill Grinder.—In our advertisement pages (*Sup.* 4) will be found an illustration of the "Sundale" patent twist drill grinder, in which the operation is reduced to such simplicity that it can be accurately performed by an ordinary labourer or a boy. The method hitherto adopted in machines for this purpose has been to imitate, in a complicated and incomplete way, the peculiar movement given to the twist drills when ground by the hand of the skilled mechanic; but in the machine now introduced by Messrs. Selig, Sonnenthal & Co., the drill is kept stationary while the emery grinding wheel is moved with unerring exactness in the curve of the clearance. In this way the grinding is rendered so simply and easy that it will no doubt lead to a much more general use of twist drills.

Currie-Timmis Patents.—We read in *Invention* that an equity suit was recently begun in Philadelphia in the Common Pleas Court, by Mr. I. A. Timmis, against the Currie-Timmis Electric and Railway Supply Company, Limited. Mr. Timmis says that himself and Mr. Currie, in May, 1887, owned jointly four patents for an electro-magnet and armature and a railway signal; that he gave to Mr. Currie a power of attorney to sell his (Timmis's) interest in the patents under certain terms and conditions; that the defendant did not comply with the authority thus conferred, but entered into an illegal and unauthorised agreement with William H. Johnstone and George R. Thompson, by which the above-named company was formed. The result has been that the complainant has received neither cash for his share of the patents nor stock of the company. He asks the Court to decree that the defendants and the company shall reassign and reconvey to him his half interest in the patents. We wonder if the Mr. Currie mentioned in this report is the same eminent electrician who went out to America in the interests of the Gordon Electric Light Company. Mr. Frank Bailey should have gone, but we believe that he refused.

The Ries Electric Railway System.—When we wrote the article on Mr. Ries's electric railway in our issue of November 16th, 1888, we had only Mr. Ries's descriptive pamphlet and letter to quote from, and we accordingly cited certain passages in his own words; our criticism was based upon the information supplied by him. The letter and patent specifications which we received last week from Mr. Ries refer to constructive details of which little or no mention was made in the original pamphlet. We have carefully perused these specifications together with the letter contained in our issue of last week, but we have found no reason to alter our opinions upon certain propositions contained in Mr. Ries's pamphlet, and we await with anxiety the results of the practical application of the principles concerning which we expressed our doubts. We cannot help admiring the ingenuity displayed in the getting-up of the recently-published U.S. specifications referred to by Mr. Ries, and we shall be glad to hear of a successful and economical application of these complicated devices for propelling street cars.

Proposed Electrical Duel.—The following are the terms upon which Mr. Harold P. Brown has offered to have an electrical duel with Mr. George Westinghouse, jun.:—"I challenge Mr. Westinghouse to meet me in the presence of competent electrical experts and take through his body the alternating current, while I take through mine a continuous current. The alternating current must not have less than 300 alternations per second (as recommended by the Medico-Legal Society). We will begin with 100 volts, and will gradually increase the pressure 50 volts at a time, I leading with each increase, each contact to be made for five seconds, until either one or the other has cried enough, and publicly admits his error. I will warn Mr. Westinghouse, however, that 160 volts alternating current for five seconds has proved fatal in my experiments, and that several men have been killed by the low-tension Jablochkoff alternating current."

The Elmore Copper Depositing Process.—We learn that the shares in "Elmore's Patent Copper Depositing Company" were applied for several times over. Indeed, we have been informed that the necessary capital was forthcoming, had it been required, from one source alone.

NEW COMPANIES REGISTERED.

Maxim-Weston Electric Company, Limited.—Capital £75,000 in 500,000 shares of 3s. each. Objects: To acquire from the liquidators of the Maxim-Weston Electric Company, Limited, the undertaking and property of that company. Signatories (with one share each): Arthur Cousens, 38, Westbourne Park Villas; J. R. McNeagh, 1, Upper High Lever Road, W.; W. White, Stock Exchange; *F. H. Hildyard, Great Dover Street, S.E.; *J. G. Couchman, Eltham Road, Lee; A. R. Ramsay and Benjamin Whitworth, jun., of 2, Metal Exchange Buildings, E.C. The first directors are the signatories denoted by an asterisk, and John Marks, 113, Great Russell Street; J. M. Klenck, 42, Bishopsgate Street, and Louis Swabey, 23, Churchfield Road, Ealing; qualification, 250 shares or equivalent stock; remuneration £1,000 per annum, to be divided as they may determine. Registered 17th inst. by Gresham and Davies, 12, Old Jewry Chambers.

Elmore's Patent Copper Depositing Company, Limited.—Capital £200,000 in £2 shares. Objects: To acquire and work the British patents of Francis Edward Elmore and Alexander Stanley Elmore relating to the treatment and electrical deposition of copper and other metals, for the manufacture of all kinds of copper and other metal articles; also to carry on the business of an electric light company in all branches. Signatories, Sir John H. Morris, 88, Queen's Gate, 500 shares; E. J. Carron, Surbiton Hill Park, 500 shares; A. Holland, 2, East India Avenue, 250 shares; Major-General P. Beadle, 6, Queen's Gate Gardens, 250 shares; J. MacFarlan, Wimbledon. 500 shares; G. Smith, West Bank, Lewisham Hill, 250 shares; F. L. Rawson (electrical engineer), 11, Queen Victoria Street, 1,000 shares. The signatories are to appoint the first directors, qualification, 250 shares; remuneration £1,500 per annum together with 10 per cent. of the net profits after payment of 20 per cent. dividend. Registered 18th inst. by Newman Hays & Co., 31, Abchurch Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Woodhouse and Rawson Electric Supply Company of Great Britain, Limited.—The annual return of this company, made up to the 11th January, was filed on the 18th inst. The nominal capital is £100,000, in £10 shares. 2,007 shares are taken up, and the full amount has been paid thereon.

Woodhouse and Rawson Electric Manufacturing Company, Limited.—The annual return of this company, made up to the 11th inst., was filed on the 18th inst. The nominal capital is £100,000, in £10 shares. 4,728 shares have been taken up, and the full amount has been paid thereon.

Anglo-American Brush Electric Light Corporation, Limited.—An agreement, dated 9th inst., and filed on the 16th inst., provides for the purchase by the company from Mr. Wm. Crookes, of 7, Kensington Park Gardens, of the following letters patent, viz.: 2,612 (1881), 3,399 (1881), and 1,079 (1882); the consideration to be £500 in fully paid shares of the company. Mr. Crookes does not warrant the validity of the said letters patent.

Bedford Electric Light Company, Limited.—The statutory return of this company, made up to the 10th inst., was filed on the 14th inst. The nominal capital

is £15,000, in £1 shares, but the only shares at present taken up are the seven subscribed for by the signatories to the memorandum and articles of association, and upon these no call has yet been made. Registered office, 3, St. Paul's Square, Bedford.

City of Westminster Electrical Syndicate, Limited.—An extraordinary meeting of the members of this syndicate was held at the office, 6, Westminster Chambers, Victoria Street, on the 19th ult., when a resolution was passed appointing Mr. Charles Stanley Peach a director jointly with the present directors, Messrs. Bonwick, Cleave, Cooper and Barnes. The resolution was confirmed at a meeting held on the 15th inst., and was duly filed on the following day.

Brighton Electric Light Comapny, Limited.—At a meeting of this company held on 20th ult, it was resolved to alter the name of the company to the Brighton and Hove Electric Light Company, Limited, and to increase the capital to £100,000 by the creation of 15,000 new shares of £5 each. The resolutions were confirmed on the 7th inst., and duly filed on the 14th inst.

Miners' Lamp Electric Lighting Company, Limited.—Upon terms of an agreement of 13th ult., this company proposes to purchase the interest of James Blackburn, of Ashley House, Woodlesford, York, and Fredk. Mori, of Leeds, electric engineer, the invention and letters patent dated 4th May, 1887, No. 6,555, for certain improvements in the lighting of safety and other lamps and wicks, and also No. 17,966, dated 31st December, 1887, for improvements in electric batteries, and in the application thereof to miners' safety lamps. The purchase consideration is £1,000, payable—£850 in fully paid shares, and the balance in cash.

London Electric Supply Corporation, Limited.—The annual return of this company, made up to the 5th inst., was filed on the 10th inst. The nominal capital is £1,250,000, divided into 200,000 ordinary and 50,000 preference shares of £5 each. 93,000 shares are taken up, the calls made being as follows:—£5 upon 51,800, £4 upon 23,200, and £1 upon 18,000. The calls paid amount to £369,800.

CITY NOTES, REPORTS, MEETINGS, &c.

Manchester Edison-Swan Company, Limited.

AN extraordinary general meeting of this company was held at the Memorial Hall, Albert Square, Manchester, on Tuesday, for the consideration of the question of electric lighting from a central station.

Mr. V. K. Armitage presided, and said that, owing to recent improvements which had been effected in electric lighting, the supply from a central station had now become practicable. The company proposed to establish a station near Piccadilly to supply 10,000 lights at an average cost of 25s. per light. The scheme would cost £40,000 to establish, and £8,000 per annum for maintenance. Profit anticipated, 10 per cent. All above to be divided among the consumers. The contract to be entered into with the Corporation of Manchester would be of the most favourable character to that body, who should have a royalty on every gaslight substituted by electricity, or by annual payment, and to be at liberty to purchase the whole of the plant at any time. This was preferable to applying to Parliament for special powers. The chairman concluded by moving a resolution to the effect that the shareholders approved the scheme, and empowering the directors to take steps to carry it out, and issue a call upon the shareholders for that purpose for sums not exceeding £2 per share.

Mr. J. C. Waterhouse seconded the motion.

Mr. Gillebrand said he felt that the proposal was a little wide of the mark and a little too philanthropical for the shareholders to indulge in. The present shares of the company were only worth 2s. 6d. in the pound. He recommended those who believed in the scheme to form a fresh company to carry it out.

The Chairman said the 2s. 6d. per share was only on a few shares which somebody disposed of in a panic, and they had immediately risen to 4s. He hoped the resolution would be passed, and he would promise that before any money was asked for there should be a further meeting of the shareholders.

Mr. Gillebrand said he had over 1,000 shares. Who would give him 3s. per share for them?

There was no offer.

Mr. Charles Hopkinson said he did not think the scheme was one which would not recommend itself to business people.

After further discussion, the resolution was carried with one dissentient.

The meeting closed with a vote of thanks to the chairman.

German Union Telegraph and Trust Company, Limited.

AN extraordinary general meeting of this company was held at Winchester House, Old Broad Street, on Tuesday, Sir James Anderson in the chair, to consi ler special resolutions requiring the company to be wound up voluntarily and appointing liquidators (in accordance with the arrangements under which the Imperial German Government would take over the cables and property of the German Union Telegraph Company, of Berlin).

The Chairman stated that the first payment made by the liquidators of the Berlin company would enable the liquidators of this company to return to the shareholders about £7 7s. 6d. per £10 share. They expected to be able to make their first payment in the first week of February; and they hoped to complete the winding up of the company, and to make a final payment to the shareholders early in May. They hoped to be able to make a total return to the shareholders of very nearly par. He concluded by moving a resolution authorising the winding up of the company.

Mr. H. G. Erichsen seconded the motion, which was adopted; and a further resolution was afterwards passed appointing Sir James Anderson and Mr. William Payton liquidators of the company. In answer to a question, the chairman added that the cable was now being worked by the German Government.

Anglo-American Telegraph Company, Limited.—The directors have resolved to recommend to the proprietors at the next half-yearly general meeting the declaration of the following dividends:—1. A balance dividend of 15s. per cent. upon the Ordinary Consolidated Stock for the year ending December 31st, 1888. 2. A balance dividend of 30s. per cent. upon the Preferred Stock for the year ending December 31st, 1888, both payable on February 2nd next, less income tax, to the stockholders registered on the books of the company on the 14th inst. After paying the foregoing dividends there will be an estimated balance of £1,325 13s. to be carried forward to the next account. The above dividends, together with those already paid, will amount to £1 12s. 6d. per cent. on the Ordinary Consolidated Stock, and £3 5s. per cent. on the Preferred Stock for the year 1888. The register of transfers will be closed from January 18th to February 1st, both days inclusive.

Bell's Asbestos Company, Limited.—The report of this company shows the result of the first year's operations to be a net profit from the ordinary trading of the company of £23,429, and a net profit from the company's asbestos estates in Canada of £10,992, a total of £34,421. Of this a sum of £5,000 is placed to reserve, and £28,584 is left for appropriation. The directors recommend (1) the payment on February 4th of a dividend of 15s. per share, free of income tax, which, with the interim dividend paid in July last, makes a total distribution of 22½ per cent. for the year; (2) the payment of a bonus of £2,250 to the directors, in the terms of the articles of association; and (3) to carry forward the balance of £3,834.

Eastern Telegraph Company, Limited.—The thirty-third half-yearly meeting of this company was held at Winchester House, Old Broad Street, yesterday (Thursday) afternoon, Sir John Pender, K.C.M.G., presiding. The directors' report and accounts, the former of which was published in the REVIEW last week, were received and adopted, the chairman having stated that after providing for interest on debentures, debenture stock, and preference shares, they were able to carry £36,616 forward to the next account, £7,219 more than was carried forward in the corresponding period of 1887. Lord Sackville Cecil and Sir Albert Cappel, the retiring directors, were re-elected.

Elmore's Patent Copper Depositing Company, Limited.—The lists of application for shares in this company closed on Wednesday. The number of shares applied for, it is stated, was over 165,000 for the 43,600 to be allotted. The shares closed at 1 to 1¼ premium, after being lower.

Cuba Submarine Telegraph Company, Limited.—A half-yearly dividend at the rate of 9 per cent. per annum is proposed by the directors, and the transfer of £4,000 to the reserve, leaving a balance of £1,308 to be carried forward.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st December are £7,359, as compared with £2,895 in the corresponding period of 1887. The September receipts estimated at £4,513 realised £4,540. The estimated receipts for the half-month ended January 15th are £2,381, as compared with £2,676 in the corresponding period of 1888.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 18th, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,195.

THE DANGER OF ELECTRIC DISTRIBUTION.

NOTWITHSTANDING the susceptibility of the public mind to suggestions of alarm, says the *Scientific American*, it is doubtful if a full realisation of the risk to which the members of the community are exposed from electric wires has been generally attained. If the recent law providing for death by electricity as the punishment of murderers never goes into effect, it will doubtless do its meed of good. It will cause a more thorough discussion of the subject in technical circles, and the idea and true conception of the danger will be disseminated among all.

Electric companies, whether supplying current for lamps or motors, have every inducement to increase the danger inevitably attendant upon their installations. The cheapest wire is the uncoated one. A wire however poorly insulated costs more ; a properly insulated one is still more expensive. The quality of the insulation at the start is only one element—its duration when exposed to the weather is another. Insuring the latter gives a further increase in cost. As the network of wires grows thicker, and as the lines cross each other more often, an additional cause of deterioration appears. The contact of swinging wires with one another tends to rub off the insulation and expose the metal. The lines which have done the damage then serve as conductors to carry off the current, possibly to a telephone box or other place where it may do much harm.

Recent experiments in death by electricity which have been made upon animals illustrate the fatal nature of the dynamic shock. In the early days of the science, the static discharge of immense potential and very small quantity was considered the most fatal. It corresponded to the lightning stroke, both in its electrical characteristics and effects. Following the developments of the last decade, dynamic currents of very high intensity are everywhere in use, and these have been found to be deadly, though of comparatively low potential. It is such currents as these that imperfectly protected wires are carrying above the streets. When the dynamos are running, contact with wires conveying such currents is liable to be fatal. A broken wire that has fallen so as to reach from the top of a pole to the street has now come to be regarded as dangerous by the populace. The dread is only too just. Repeated deaths have proved it so.

It is futile to attempt to restrain the march of progress. No advance in practical science is more remarkable than the development of electricity. Goethe's prediction, true for so many years, is now being falsified. He said that electricity would only be applied to the minor uses of life. Now engines are driven by it, and the difficulties in the way of its application to outdoor locomotors are gradually disappearing. The electric light is practically complete in its development. But while no effort should be made to restrict the uses of the current, the fact that it is dangerous should not be overlooked. The rival exploiters of different systems claim each a higher degree of safety, or more properly a less degree of danger, for his own installation. The direct and alternating current advocates are engaged in active attack upon each other on the basis of the relative harmfulness of the two systems One engineer has suggested a species of electric duel to settle the matter. He proposes that he shall receive the direct current, while his opponent shall receive the alternating current. Both are to receive it at the same voltage, and it is to be gradually increased until one succumbs, and voluntarily relinquishes the contest. The absurdity of the suggestion, which is made in apparent earnestness, shows how decided the war has become. Back of it all the fact remains that the working current of the day, direct or alternating, is dangerous. One solution seems adapted to protect the public. It is to properly dispose of the wires underground.

In examining the effects of the dynamic current upon the systems of animals, several points of interest have been developed. One such point is the small ampèrage required for a fatal result. Thus, with a current of 536 volts electromotive force a dog, with a resistance of 11,000 ohms, was killed. This reduces to a current of less than 0·05 ampère, leaving out of consideration the resistance of the dynamo. A horse weighing 1,230 lbs. was killed by a current of about 0·06 ampère. In the case of the alternating current, the question of time seems to enter. A current requires a certain period to destroy life, which period varies with the current intensity. These data go to prove how slight a contact with the wires may be fatal. Sooner or later the plan of a modern city will have to provide some effective system of subways. The overhead wires will be a perpetual menace, will be the cause of death and injury.

But a few days have elapsed since a forcible illustration of these dangers occurred. A storekeeper in Meriden, Conn., started to take in some articles of clothing that had been hung up in front of his store. It was raining at the time. He was thrown violently back by an electric shock as soon as he attempted to remove a knit jacket. He soon recovered, and continued his work only to receive an additional shock, which scorched his hand. The attention of bystanders was excited, and it was found that brilliant flashes of light could be drawn from the iron front of the store. On investigation it was found that an electric light wire had come in contact with the wet awning, and thus had caused the trouble. Here, at least, is a case where it would be hard for the electric light company to plead contributory negligence.

THE ELECTRICAL DEPARTMENT AT PORTSMOUTH DOCKYARD.

IN connection with the vast changes which have been introduced into the Royal Navy during the last quarter of a century, nothing can be more striking than the development of the use of electrical apparatus on board our men-o'-war. Fourteen or fifteen years ago the electric light was practically unknown so far as the illumination of ships was concerned, and at that time the electrical staff at Portsmouth were principally engaged in carrying out minor repairs to the apparatus for firing guns and to electric bells. So great has been the progress effected since then that Mr. W. Lane, the electrician of Portsmouth Dockyard, has now 84 workmen on the books of his department, besides apprentices. The electric shop, which is situated in the extension works and has been enlarged on several occasions to meet the growing demands upon the department, is about 240 feet by some 40 feet. The workmen are mainly employed, under the supervision of Mr. Lane and his assistant Mr. Wooler, in the manufacture of various instruments for the service and in the repair of electrical stores, which are all returned to the electrical depôt. Until a year or two since the whole of the big vessels were fitted out with the electric light by private contract, but at the present time the apparatus only is supplied through this agency, and the installation is effected by the electrical staff. Among the ships at present in the hands of Mr. Lane are the *Trafalgar* (the apparatus for which has been supplied by Messrs. Siemens & Co.), and the *Anson* (apparatus by Messrs. Latimer Clark, Muirhead & Co.) In course of time it is believed that an attempt will be made to manufacture certain electrical machinery in the dockyard, but in that case it would be necessary to afford more accommodation than there exists at present. By way of experiment a dynamo is about to be constructed in the shop. Another important electrical question now under consideration is that of the lighting of the dockyard. Hitherto when it has been found necessary to keep the dockyard workshops open at night, electric installations have been temporarily rigged up, but it is now considered desirable in some quarters to light the whole dockyard by electricity,

the suggestion being that this might be economically effected by the utilisation of the superfluous power at the pumping station. The matter is, it is understood, now engaging the attention of the Admiralty.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

We are indebted to the secretary of the Institution of Electrical Engineers for an advance proof of Mr. Jamieson's paper announced for reading yesterday.

"The insulation resistance of electric lighting installations." By Prof. A. Jamieson, F.R.S.E., M.Inst.C.E., Member.

Insulation resistance of land lines and submarine cables.—In the early days of telegraph land lines and of submarine cables, *insulation resistance* was neither definitely specified for nor accurately measured during the various processes of manufacture and of maintenance. A few failures, however (in some cases dearly bought), soon impressed electricians with the necessity for paying more attention to this important quality, and they were not long in demanding from contractors the minimum of insulation resistance which would enable their lines to be worked with success. Not only are careful insulation tests now made during the manufacture of insulators and the erection of the land lines under the British Postal Telegraph Department, but "daily tests" are taken of all the more important lines. The minimum insulation resistance which each insulator should have depends upon the length of the line. For a line of 100 miles long each insulator is expected to give a resistance of 500 megohms, whereas for a line of only 10 miles 50 megohms is considered sufficient. When a line has been erected and put into working order it is usual to fix upon a minimum standard insulation resistance per mile. If the measured value at any time falls below this standard then the line is considered faulty, and steps are taken to remove the fault. The Post Office standard is 200,000 ohms per mile. In the cases of subterranean lines and of submarine cables an even still more rigid and careful system of inspection and of testing is now carried out during the manufacture of the cores and cables. The results are invariably reduced to an insulation resistance per unit of length at a standard temperature. The following extract from the specification of a successfully made and laid cable will serve to illustrate this:—"The insulation resistance per knot of the gutta-percha core shall not be less, when tested at 75° Fah., than 300 megohms, 14 days after manufacture and after two minutes' electrification. If the resistance of *any* portion of the gutta-percha (reduced to 75° Fah.) at any period of the manufacture fall below the above specified limit, the cable to be rejected." Throughout the whole of the operations of coiling and uncoiling a cable into the shore and ship's tanks, during the laying, and subsequently during its existence, the insulation resistance is periodically measured and tabulated.

Results of Neglecting Insulation Resistance in Electric Lighting.—We have been induced thus to particularise the extreme care and attention which is now considered absolutely necessary in the case of landlines and of submarine cables, because the industry of electric lighting has just passed through a similar experience to that which these industries met with in their earlier days. When the industry of electric lighting was first beginning to take root in this country, electric light engineers pooh-poohed the idea of accurately measuring the insulation resistance of any part of their work, and they invariably turned a deaf ear to the timely warnings of telegraph-engineers and electricians. Experience has, however, taught them, as it did their elder brothers, that good uniform insulation resistance throughout an installation is of immense importance, and that it cannot be obtained without careful attention to details and a rigorous system of testing during manufacture, erection, and after completion. If an installation is not well insulated throughout, leakage of the current takes place, and consequently waste of power and money; electro-chemical action sets in where damp or liquids are present, and the conductor is thereby eaten through or a short circuit occurs, which for a time stops the whole of the lighting. Discredit thus not only falls upon the contractor, but others are frightened from employing the electric light, to the detriment of the industry as a whole.

Necessity for Discussing a Standard of Insulation Resistance.—The terms usually employed in regard to the insulation resistance of an electric light installation are, that it shall be "good" or "perfect," according to the fancy of the party purchasing the plant or of his adviser. These terms have, however, no specific meaning, and are therefore very variously interpreted. No doubt the Society has had this subject before it in committee when drawing up its set of rules for the "prevention of fire risks;" but the Institution as a whole has never had an opportunity of discussing it, and thereby of impressing its members and the public generally with its importance, and the necessity for observing some minimum standard of insulation resistance. The writer had his attention directed the other day to a communication read before the International Society of Electricians, Paris, in November last, by M. Picou, wherein that gentleman ably analysed this question, and proposed a rule based upon tests of short lengths of cotton-covered insulated wire. He has not had an opportunity, however, of learning the extent and the nature of the discussion upon M. Picou's paper, and he can only, therefore, place his rule before the members, along with a few other rules, and leave them to form their own opinions, guided by their practical experience.

General Propositions.—The following points will no doubt be readily admitted in regard to insulation resistance of electric lighting installations:—

1. That, owing to the comparatively low resistance of the conductor circuit of ordinary electric light installations on the parallel incandescent system, the minimum standard of insulation resistance does not require to be nearly so high per unit of length as in the case of submarine cables.

2. That it should be directly proportional to the electromotive force of the generator, or difference of potential between the conductor and earth, or between the forward and return conductors.

3. That it should be inversely proportional to the total length of insulated conductor, or to the total current, or to the number of lamps in circuit.

4. That, whatever rules or standards of insulation resistance may be adopted, they should be applied, not only to all the conducting wires, but also to the dynamo, the lamps, and all the fittings, or, in other words, to the *whole* circuit.

Rules.—1882 *Set of Rules by Society of Telegraph-Engineers and Electricians.*—In May, 1882, in the first set of "Rules and Regulations for the Prevention of Fire Risks arising from Electric Lighting," issued by the Society of Telegraph-Engineers, no standard of insulation resistance or of minimum leakage is recommended. All that we find there on this head is: "The difficulties that beset the electrical engineer are chiefly internal and invisible, and they can only be effectually guarded against by testing or probing with electric currents;" "All wires used for indoor purposes should be efficiently insulated," &c.; "The insulation of dynamo coils and conductors should be practically perfect;" "The value of frequently testing the apparatus and circuits cannot be too strongly urged," &c.

Five years ago even, the writer is not aware that any published rule existed, or that any specification contained any definite rule for the insulation resistance of any part of any electrical installation.

Admiralty Rule.—About 1883 or 1884, however, the Admiralty officials requested that the insulation resistance of the dynamos supplied to them should withstand the test of stroking the free end of a conducting wire (the other end being connected to either pole) over any part of the framing without showing any signs of a sparking when the machine was driven at its normal speed. The writer does not know whether they still insert this clause in their specifications, or whether they have modified or improved it; but at best it is only a rough-and-ready test, and gives no indication whatever as to the precise locality of a fault or its value in ohms.

Workman's Tests.—The only test applied by contractors when wiring an installation was, and often still is, that of simply inserting an ordinary lineman's detector or galvanometer, G, between a

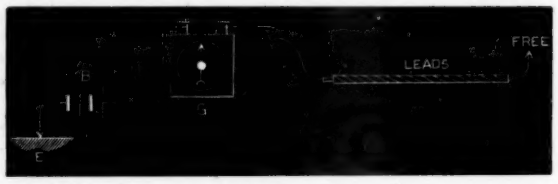


FIG. 1.

battery, B (of one or two cells), and the leads, with the other end or ends freed, as in fig. 1. If the galvanometer gives no deflection, or a very small one, then the section is passed as all right.

This is such an exceedingly simple and handy test for workmen that it can scarcely be improved upon, but it gives no precise indication whatever of the resistance in ohms, of the dielectric, or of the fittings. It simply informs the observer whether there is a bad fault or not. He can also find out by it whether the continuity of the conductor is complete, by earthing the further

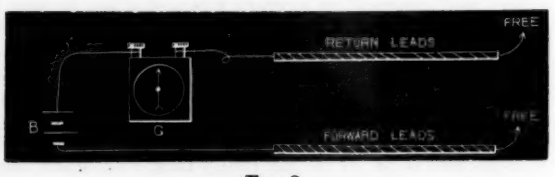


FIG. 2.

end; and he can also ascertain whether there is a short circuit or not between any two or more "forward" and "return" leads by connecting up his apparatus as shown in fig. 2.

In 1884 Messrs. Wm. Denny & Brothers' electrician used a small portable magneto-electric machine and sensitive bell—the same as telephone companies employ—instead of the above-mentioned galvanometer and battery. If the bell rang, a fault existed, and its position had to be found out; if it did not, then all was supposed to be right. He, however, in addition to this merely workman's test, applied a more exact test by Wheatstone

bridge, and thus obtained the insulation resistance of the whole or of any desired portion of the circuit and the fittings in ohms.

Prof. Jamieson's Rule.—In 1884, whilst testing the electric light wires and fittings of some ships, the writer first drew up his rule, which has been published in the last three editions of Munro and Jamieson's "Pocket-Book of Electrical Rules and Tables." He had previously (since 1881) tested by Wheatstone bridge, &c., the insulation resistance of a number of land and ship installations, and was rather surprised at the variety and lowness of the dielectric resistance, for his ideas of insulation resistance had been somewhat magnified by seven years' experience with submarine cables. At first he could not get contractors to come up to his rule, but he was much gratified about this time by the enthusiasm and interest which Messrs. Wm. Denny & Brothers' electrician took in the matter, and by finding such good results in his tests of their ships' lighting leads, which results so far surpassed the demands of his rule that he decided to adhere to it. Since then he has had much less difficulty, and when care and attention to cleanliness in jointing, to the fixing of wires and fittings, as well as in the manufacture of dynamos, are observed, he has frequently found that the insulation exceeded the demands of his rule, which is as follows:—"A careful insulation resistance test of each circuit, and finally of the whole of the circuits (including all switches and terminals, but not necessarily the lamps) joined up together, should be taken by the method described above,* and not passed unless the resistance is at least equal to ·1 Ω per lamp for every volt employed. The insulation resistance of the dynamo coils should be equally good."

Put into formula shape, the rule is—

$$R_I = k\frac{E}{N_L}$$

where R_I = the total insulation resistance of the whole or any part of the lamp circuits or of the generator in ohms;
k = a constant (·1 Ω = $\frac{1}{10}$ Ω = 100,000 ω) found from actual tests of several well-erected installations;
E = E.M.F. of dynamo or installation in volts;
N_L = number of lamps (16 C.P.) on each circuit or on the whole circuit.

The insulation resistance is, therefore, here taken to be *directly* proportional to the normal E.M.F. of the dynamo, and *inversely* proportional to the number of 16 C.P. lamps in circuit. The difficulty of ascertaining the precise length of the mains, submains, leads, and dynamo windings led the writer to substitute the number of lamps in circuit for what might at first sight appear to be the more exact term in the denominator, viz., the length of conducting wires employed. Although not stated in the above quotation of his rule, the writer usually applies the same test for the resistance or percentage leakage of current between the whole system of forward and return wires; also between the dynamo armature with field-magnet coils in circuit and the frame or body of the machine, as well as between the series and shunt-magnet coils if the dynamo is of the compound or series-shunt type.

The following example and table will make the application of this rule clearer:—

Suppose that we have an installation of 100 lamps of 16 C.P. each, and that the normal difference of potential between the terminals of the dynamo is 100 volts, then the insulation resistance should not be less than

$$R_I = k\frac{E}{N_L} = 100{,}000\ \omega\ \frac{100v}{100L} = 100{,}000\ \omega = \cdot1\ \Omega.$$

Table of Insulation Resistances required by Jamieson's Rule.
For 16 C.P. Lamp Circuits and Dynamos.

Number of lamps in circuit.	50-volt lamps.	65-volt lamps.	80-volt lamps.	100-volt lamps.	110-volt lamps.
	Ohms.	Ohms.	Ohms.	Ohms.	Ohms.
1	5,000,000	6,500,000	8,000,000	10,000,000	11,000,000
10	500,000	650,000	800,000	1,000,000	1,100,000
20	250,000	325,000	400,000	500,000	550,000
40	125,000	162,500	200,000	250,000	275,000
50	100,000	130,000	160,000	200,000	220,000
100	50,000	65,000	80,000	100,000	110,000
150	33,333	43,333	53,333	66,666	73,333
200	25,000	32,500	40,000	50,000	55,000
300	16,666	21,666	26,666	33,333	36,666
400	12,500	16,250	20,000	25,000	27,500
500	10,000	13,000	16,000	20,000	22,000
1,000	5,000	6,500	8,000	10,000	11,000

* See Munro and Jamieson's "Pocket-Book of Electrical Rules and Tables," p. 179, at foot. This rule applies only to the dynamos, leads, and fittings for incandescent lamps arranged on the single parallel system. Should the lamps be arranged in parallels, with two or three or more lamps in series in each parallel, they count as but one for each parallel.

The leakage allowed by this rule in the case of 100-volt lamps, using ·64 ampère of current per lamp, is

$$c = \frac{E}{R} = \frac{100\ v}{10{,}000{,}000\ \omega} = \frac{1}{100{,}000}\ \text{ampère of leakage}$$

for every lamp in circuit. Each lamp, however, requires ·64 ampère; consequently the leakage = $\frac{1}{64{,}000}$ part of the total current.

Or, the percentage leakage = $\frac{1}{6400}$ = ·0016 per cent.

Since by the above rule the dynamo requires to have the same insulation resistance as the lamp circuit, the insulation resistance of the *whole* circuit, including the dynamo, is half of that given by the formula and tables, and therefore the leakage is double, or $\frac{1}{32000}$th part of the total current, or $\frac{1}{3200}$th per cent. = ·0032 per cent.

Phœnix Fire Office Rules.—In May, 1888, in the thirteenth edition of the Phœnix Fire Office Rules, Mr. Heaphy recommends that "in any electric light installation in which the current is continuous, and has an electromotive force of 200 volts or under, the insulation resistance over the whole circuit inside any buildings should never run below 10,000 ohms. . . . . With currents of 1,000 volts the insulation resistance should never drop below 50,000 ohms, no matter how wet the weather may be. For alternate currents the minimum insulation resistance should be twice the above number of ohms respectively."

In November, 1888, in the fourteenth edition, Mr. Heaphy is more precise, and he has added a table based upon similar proportions to the writer's rule.* His Rule No. 27 reads as follows:—"In any electric light installation in which the current is continuous, and has an electromotive force of 200 volts or under, the insulation resistance over the whole installation should not be below the following:—

"Installations of	25 lights	...	500,000 ohms.
"	50 "	...	250,000 "
"	100 "	...	125,000 "
"	500 "	...	25,000 "
"	1,000 "	...	12,500 "

"When the lights are proportionate between the above numbers, then the insulation resistance should be correspondingly proportionate. The insulation resistance of separate circuits of the installation should also be taken, and should be in accordance with the above table. For alternate currents the minimum insulation resistance should be twice the above number of ohms respectively."

Objections to Phœnix Rule.—The following objections may be offered in regard to this last rule:—

1. It ties down a contractor to one and the same insulation resistance whether the E.M.F. of the installation lies *anywhere* below 200 volts. Surely a 50-volt installation requires but half the insulation resistance of a 100-volt one, and but one-fourth that of one with 200 volts?

2. It is somewhat doubtful (owing to a previous note to Rule No. 20) whether the words "over the whole installation" include the dynamo as well as all the wires, fittings, and lamps?

3. No distinction is made between circuits with one, or two, or more lamps in each parallel.

4. Arc lamps of 2,000 C.P. or more in parallel, and large incandescent lamps of 500 C.P. or more, which require strong currents, come under the same general words, "any electric light installation in which the current is continuous," just as much as small incandescent lamps of, say, 5 C.P., which require only a fraction of an ampère.

A question naturally arises here for discussion—Should not the insulation resistance in such extreme cases bear some definite proportion to the current?

Westminster Fire Office Rule.—In 1888, the Westminster Fire Office issued a set of rules for guiding their officers in regard to electric light installations, in which they demand that the insulation resistance shall in no case be less than 150,000,000 ohms per mile!!! Surely they have been blindly making extracts from a submarine cable specification! No contractor could be expected, under ordinary circumstances, to complete his work (including dynamo and fittings) to such a high standard.

M. Picou's Rule.—On November, 7th, 1888, M. Picou communicated his rule to the International Society of Electricians, Paris.† Using the same symbols as in the writer's rule, it is—

$$R_I = k\frac{E}{C},$$

where R_I = the total insulation resistance of the circuit in ohms;
k = a constant (500) found by experiments with short lengths of wire covered with three layers of cotton wound in reverse layers and pressed between metal plates;
E = maximum E.M.F. of the generator in volts;

* It will be observed that the above table corresponds identically with the writer's rule for an E.M.F. of 125 volts; *e.g.*, take 100 lamps; then

$$R_I = k\frac{E}{N_L} = 100{,}000\ \omega\ \frac{125\ v}{100\ L} = 125{,}000\ \text{ohms};$$

and so on in proportion to the number of lamps.—A. J.

† See ELECTRICAL REVIEW, November 23rd, 1888.

C = total current generated or passing through circuits in ampères;

$\frac{E}{C}$ = the resistance in ohms of the whole circuit when the installation is in full working order.

The differences between M. Picou's rule and the writer's lie in the different values given to the constant, k, and in the substitution by M. Picou of the total current, C, for the total number of lamps, N_L, in the writer's rule. There is no doubt an advantage in thus substituting C for N_L, since the constant k thereby expresses directly the number of times the insulation resistance is of the apparent working resistance, $\frac{E}{C}$. And its reciprocal, the proportion which the leakage current bears to the total current. For, let c = the leakage current, and adopting the same symbols as above for the other terms, then

$$c = \frac{E}{R_1} = \frac{E}{k\frac{E}{C}} = \frac{C}{k},$$

$$\therefore \frac{1}{k} = \frac{c}{C} = \frac{\text{leakage current}}{\text{total current}}.$$

We, however, consider that M. Picou's constant, 500, is by far too low to ensure good and lasting work. By it a circuit of 1,000 lamps of 16 C.P. each, requiring 100 volts and ·64 ampère each, the total insulation resistance of the circuit would only need to be 78·1 ohms, instead of 10,000 ohms by the author's rule (or 5,000 ohms if the dynamo be included).

The Society of Telegraph-Engineers and Electricians' Last Rule.—In April, 1888, this Society issued its second pamphlet of "Rules and Regulations for the Prevention of Fire Risks," and Rule 16 states that "the insulation of a system of distribution should be such that the greatest leakage from any conductor to earth (and in the case of parallel working from one conductor to the other when all branches are switched on, but lamps, motors, &c., removed) does not exceed $\frac{1}{5000}$ part of the total current intended for the supply of said lamps, motors, &c.; the test being made at the usual working electromotive force." This rule includes all kinds and systems of electrical installations, and it is very neatly and concisely expressed. Some persons have, however, a difficulty in understanding how the $\frac{1}{5000}$th part of the total current is to be tested for or ascertained, and others do not see exactly how the test is to be applied to different parts of the circuits at the usual working E.M.F. *before* the installation is put into working order.

If the rule had also been put into the following form, with a table giving the insulation resistances required for a few of the more common electromotive forces and currents (or number of lamps), it would no doubt have recommended itself more readily to those unaccustomed to deal with the form of expression used in the rule. Using the same symbols as before, we have—

$$\frac{1}{5{,}000}\,C = c = \frac{E}{R_1},$$

$$\therefore R_1 = 5{,}000\,\frac{E}{C} = k\,\frac{E}{C},$$

which is the form of expression used before, and most easily applied. This gives a constant 10 times as great as M. Picou's, and about one-tenth that of the writer's rule. Which of these constants is most in accordance with good practice?

Table of Insulation Resistances required by the Society of Telegraph-Engineers and Electricians' Last Rule, viz.:—The leakage of any part of an installation not to exceed $\frac{1}{5000}$ of total current supplying that part; or,* $R_1 = 5{,}000\ E/C$.

Number of ampères in circuit.	For 50-volt lamps.	For 65-volt lamps.	For 80-volt lamps.	For 100-volt lamps.	For 110-volt lamps.
	Ohms.	Ohms.	Ohms.	Ohms.	Ohms.
1	250,000	325,000	400,000	500,000	550,000
10	25,000	32,500	40,000	50,000	55,000
20	12,500	16,250	20,000	25,000	27,500
40	6,250	8,125	10,000	12,500	13,750
50	5,000	6,500	8,000	10,000	11,000
100	2,500	3,250	4,000	5,000	5,500
150	1,666	2,166	2,666	3,333	3,666
200	1,250	1,625	2,000	2,500	2,750
300	833	1,083	1,333	1,666	1,833
400	625	812	1,000	1,250	1,375
500	500	650	800	1,000	1,100
1,000	250	325	400	500	550

Different tests.—The ordinary Wheatstone bridge test is the handiest and easiest method of ascertaining the actual resistance in ohms of the conductors as well as of the insulation resistance. Should the insulation, however, be too high for the battery power and the galvanometer, then the direct deflection substitution method may be adopted. These tests are so fully described in every book on testing, and are, besides, so well known, that there is no need to explain them here. The battery power need only be a few Leclanché cells (10 or 12 at most) if the galvanometer used is of the sensitive-mirror Thomson type.

When the installation has been completed then the whole of the results may be obtained by means of ordinary ampère and volt meters.

First, join up the circuit as follows, in fig. 3:—

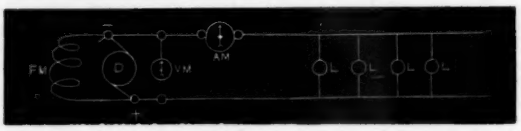


FIG. 3.

Work the installation at its normal power and observe the total current, C, by the ampère-meter, A M, and the difference of potential, E, by the voltmeter, V M. This gives us $\frac{E}{C}$.

Second, join up the voltmeter as in fig. 4, with one side to earth, having previously ascertained its resistance, r, ohms. Also note, C, on the ampère-meter, and see that it is the same as before.

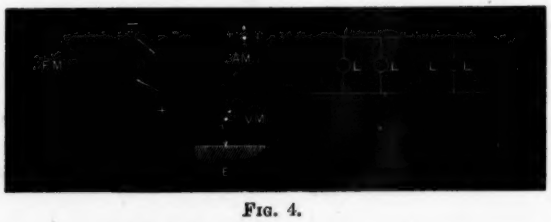


FIG. 4.

If any leakage to earth exists in the dynamo or in any part of the circuit, a deflection on the voltmeter, V M, will be produced corresponding to the leakage current, c, passing through it, and is represented by e, volts difference of potential between its terminals.

Then, $\frac{e}{r} = c$, the total leakage current.

But $\frac{C}{c} = k$, the actual constant or coefficient of the insulation resistance of the system.

Then, if this value is greater than k, our standard constant, the installation may be considered all right as far as insulation resistance is concerned. Of course this does not inform us if any leakage is taking place between the forward and the return system of wires, or between the shunt and the series windings of the dynamo.

To ascertain the former of these, disconnect all the lamps and insert the voltmeter first in the forward lead, and secondly in the return lead, as in fig. 5, and note if we get any leakage current, c, when the dynamo is run at its normal speed. In regard to leakage between the shunt and series windings of the dynamo magnets, recourse must be had to the Wheatstone bridge test.*

FIG. 5.

No doubt some of the members will suggest other practical tests, as well as give their experiences of how the insulation resistance of installations with which they happen to be intimately acquainted compare with the various rules herein mentioned, as well as how they stood the test of time—wear and tear of everyday work. What is chiefly wanted is to ascertain the minimum standard of insulation resistance compatible with good honest work and ordinary careful usage.

P.S.—Since correcting the proof sheets of this paper the writer thought that it might be interesting and instructive if he obtained the insulation resistance of an installation that had been working for some years, because members and others might say that some of the foregoing rules were all very well for *new* work, but were quite inapplicable to *old* work. He accordingly went to-

* If we include the dynamo as well as the whole of the lamps, motors, &c., will the insulation resistance of the whole installation in the working circuit be half the above figures?

* For other tests when the installation is at work, see Munro and Jamieson's "Electrical Rules and Tables," 5th edition, pp. 215, 216.

day (January 16th, 1889) to Messrs. Graham's large East India offices and warehouses in Cathedral Street, Glasgow, with his testing apparatus, and took careful tests of the insulation resistance of the whole circuit, with the results shown in the following table :—

Original date of fitting up installation	1881–82
Date on which most of the wiring was renewed	1883
Day of test (day wet—Glasgow weather)	Jan. 16th, 1889
Total number of lamps in circuit of 16 C.P. each	281
E.M.F. at brushes of dynamo, in *volts*	108
Current total from dynamo for all lamps, in *ampères*	(*about*) 160
Insulation resistance of dynamo armature and magnet coils alone, in *ohms*	40,000
Insulation resistance of the *whole* circuit, including the dynamo, *all* leads, switches, cut-outs, and lamps in *ohms*	21,400
Insulation resistance to pass Jamieson's rule, including *dynamo* as well as the *whole* lamp circuit, in *ohms*	19,217
Insulation resistance to pass Society of Telegraph-Engineers and Electricians' rule (if their constant includes *dynamo* as well as the *whole* lamp circuit), in *ohms*	3,375

This old installation (the oldest large incandescent light one in Scotland), which has been in full daily working order for over five years (since the wiring was renewed) when tested, without warning or any special preparation, and on a very damp day, gave a better insulation resistance than that demanded by the writer's rule, and over six times that required by the Society of Telegraph-Engineers' rule (taking it in its broadest sense).

It is worth mentioning that the president, Sir William Thomson, has taken a special interest in this installation from its very commencement. In 1881, when so few electricians knew practically how incandescent lighting should be carried out, and when the Messrs. Graham were erecting their large new premises, they consulted Sir William Thomson as to whether or not they could rely upon the electric light. Upon his recommendation they fitted their premises throughout with the electric light, without introducing gas burners into any of their offices or warehouses. The actual carrying out of the present wiring of the building has been entirely done by one of the writer's students, who has had charge of the installation for the last six years. The Messrs. Graham have been so pleased with the care and attention which he displayed that they have sent him to their new premises which they are at present erecting in Oporto, Portugal, to superintend the building and put up an electric light installation there.

The dynamo which the writer tested, and which gave a total insulation resistance of 40,000 ω, against framing and dead earth, is a Manchester shunt-wound machine by Messrs. Mather and Platt, put down about two years ago to replace the direct lighting of the building by three of the oldest shunt-wound dynamos in existence. These three machines are now employed in charging accumulators which serve to feed the lamps used in the darker parts of the building during the daytime. The writer tested the insulation resistance of one of these old machines, and found that it gave for armature and shunt coils just over 10,000 ohms, as against the frame of the machine.

In addition to the above tests, that indicated by fig. 4 was applied, and no perceptible leakage current whatever was observable on the voltmeter, even although the sensitive coil, which reads to less than a volt, was inserted.

The writer might give the results of several new installations which have surpassed his rule, and which therefore far exceeded the demands of the Society's rule. He therefore thinks that the constant of the latter might be raised from 5,000 to 10,000 with perfect fairness, and with beneficial results to the electric lighting industry as a whole.

NEW PATENTS—1889.

266. "A bracket to support the ear piece of telephones and other similar instruments." T. BOOTHBY. Dated January 7.

276. "Portable dynamo-electric signalling apparatus for military and other purposes." C. GRANT. Dated January 7.

278. "Lightning conductor for telegraphic purposes." G. WEHR. Dated January 7. (*Complete*)

282. "Improvements in conduits for electric mains." F. COATES. Dated January 7.

292. "Improvements in electric alarm thermometers." P. F. LUCK. Dated January 7. (*Complete.*)

306. "A new method of ornamenting metal articles by electro deposit process on the articles, and filling in the ornaments with japan, varnish, paint, or enamel." W. H. JONES, W. H. JONES, and B. H. JONES. Dated January 8.

319. "Improved apparatus and connections for charging and discharging storage batteries." W. P. KOOKOGEY. Dated January 8. (*Complete.*)

320. "Improved methods of preparing solution compounds for galvanic batteries." W. P. KOOKOGEY. Dated January 8. (*Complete.*)

342. "Improvements in or relating to the regulation of dynamo-electric machines." W. M. MORDEY. Dated January 8.

361. "Improved methods of and apparatus for welding, forging, and otherwise working metals by the aid of electricity." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated January 8. (*Complete.*)

362. "Improved methods of and apparatus for welding, shaping, and otherwise working metals by the aid of electricity." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated January 8. (*Complete.*)

375. "Improvements in electric glow lamps." A. BERNSTEIN. Dated January 8. (*Complete.*)

377. "Improvements relating to the rivetting of metal plates and other objects by the aid of electricity." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated January 8. (*Complete.*)

385. "Improvements in electrical apparatus for preventing collisions between railway trains." J. A. WILSON and F. M. YOUNG. Dated January 9.

434. "Dry galvanic cells." C. H. MEHNER. Dated January 9. (*Complete.*)

435. "Improvements in dynamo-electric machines." J. H. HOLMES. Dated January 9.

485. "Improvements in electric generators." H. E. NEWTON. (Communicated by D. Piédrahita, France.) Dated January 10.

506. "Improvements in electrical switches, chiefly designed for use in connection with apparatus for obtaining synchronic movements for telegraphic and other purposes." H. H. LAKE. (Communicated by E. F. Law, Turkey.) Dated January 11. (*Complete.*)

549. "Indicating the level of water, or contents of liquids in tanks or other vessels, by means of a transmitter and recorder worked by means of electricity." H. W. C. COX. Dated January 11.

586. "Insulating blocks for use with casings containing electric wires." F. BATHURST. Dated January 12.

588. "Improvements in secondary batteries." B. M. DRAKE and J. M. GORHAM. Dated January 12.

608. "Firing fog or other signals upon, or in connection with, a railway or tramway, either electrically or mechanically, the same being under control of authorised person." W. ARMSTRONG and A. F. BALL. Dated January 12.

614. "An improved form of electrical locking switch." W. N. NAYLOR and W. J. NAYLOR. Dated January 12.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888.

804. "Improvements in electric clocks." M. PULVERMANN. Dated January 18. 8d. Claims :—1. An electric clock in which a polarised armature gives motion to two levers, each actuating a pawl in such a manner that the said pawls, through suitable gearing, alternately operate the escapement wheel so as to advance the hands of the clock, each pawl in turn temporarily preventing the forward movement of the escapement wheel after such pawl has advanced it one tooth. 2. The improved electric clock hereinbefore described and illustrated in the drawing.

1557. "Improvements in duplex telegraphy." F. JACOB. Dated February 2. 8d. Relates to the arrangements described in the No. of the REVIEW for January 5th. Claims :—1. In combination with the actual and artificial cables and appliances employed for duplex telegraphy, an artificial line or cable similar in all its electrical qualities to the earth cable or conductor connecting the operating station to the sheathing of the actual cable or to other earth connection, applied and connected as and for the purpose set forth. 2. In combination with the arrangement referred to in the preceding claim, a condenser applied and connected as and for the purpose set forth.

2259. "Improvements in thermo-electric and furnace batteries." H. MESTERN. Dated February 14. 8d. In the improved furnace battery the thermo-electrical elements are composed of an easily melted positive electrode, formed of antimony and zinc. This is dovetailed into the electrode formed of copper and nickel in such a way that an increased zone of contact, and also a more intimate co-working and mutual action is attained. A layer of asbestos insulates these elements from the envelope or case, and from a protecting cap, which encloses one end of the envelope when preferred. Both the case and cap are formed of iron or nickel, or some other suitable metal, capable of affording the necessary resistance. The case and cap form a channel for the negative electrode. The claims are 3 in number.

7826. "Improvements in galvanic generators." H. B. COX. Dated May 29. 8d. The object of the invention is to provide improved mechanical means whereby the electrolyte or solution in the cells is kept in a constant state of agitation, thus preventing polarisation of the plates or electrodes. A further object is to provide automatic means whereby the plates or electrodes can be removed from the electrolyte or solution, and the generation of electricity be stopped. The claims are 16 in number.

8170. "Improvements in and relating to automatically regulated electro-motors." H. J. ALLISON. (Communicated from abroad by the Baxter Electric Manufacturing and Motor Company, Incorporated, of Baltimore.) Dated June 5. 8d. Consists partly in an improved construction for the magnet coils, partly, in an improved means for connecting the same with a shunt box, and partly, in an improved means for diminishing the friction of the governor, and for regulating and varying the resistance to its movements. The improvements are especially adapted to motors which use a constant current such as is employed in arc light circuits, and the speed of the motor is regulated by modifying the strength of the magnetic field automatically by the action of the governor. The claims are 10 in number.

10415. "Improvements in the manufacture of electrical dry elements." C. GASSNER, Jun. Dated July 18. 4d. Claim:—The production of hydrated peroxide of iron in galvanic dry elements by chloride of iron in combination with a chemical body contained in the exciting or agitating mass or developed therein by the action of the current which absorbs chlorine from the chloride of iron.

10524. "Improvements in electric railways." B. J. B. MILLS. (A communication from abroad by the Bentley-Knight Electric Railway Company of New York). Dated July 20. 11d. Consists chiefly in continuing at the point where the conduit containing the conductor ends, exposed supply conductors carried by posts placed a foot or more in height along the road at intervals, contact devices on the car or cars additional to those used for the conduit, being provided. These contact devices are adapted to be thrown into operative position to connect the motor electrically with the elevated exposed conductors when the section of the road having such conductors has been reached. Further relates to the means of supporting the motor upon the vehicle, the motor being geared to a single axle while supported on a frame outside the axle so that its whole weight rests on the axle, thereby increasing the tractive power of the vehicle. A further portion of the invention consists in employing with a motor on a car an enclosing case of non-resonant material like canvas, oilcloth or ferflax, by which the noise of the motor and gearing is reduced. Further relates to an electrical or circuit controlling regulator for the propelling motor which is controlled by the same manual device at each end of the vehicle, by which the brake for the vehicle is actuated. Further relates to a form of electric resistance in which a series of metallic plates are placed in superficial contact stationary relatively to one another, while the contact device is movable relatively to the whole series and by sweeping over the plates brings more or less of them into the circuit. The claims are 47 in number.

11092. "An improved combination of a steam engine having a vibratory and partly circular motion with a dynamo-electric machine." G. M. CAPELL and J. S. RAWORTH. Dated July 31. 6d. Claims:—1. The combination of a steam engine, in which a piston vibrates in a cylinder through an arc about the axis thereof, with a dynamo-electric machine, substantially as and for the purpose hereinbefore described with reference to the figures. 2. The combination of a steam engine, in which a piston vibrates in a cylinder through an arc about the axis thereof, a dynamo-electric machine, and a link adapted to relieve the dynamo bearing from the direct strain of the engine, substantially as set forth.

11817. "Improvements in electric furnaces." J. C. HOBBS. Dated August 16. 6d. Claims:—1. In an electric furnace, a lining for the walls thereof consisting of sawdust, substantially as set forth. 2. In an electric furnace in which the current passes through the charge, an envelope or covering for the charge consisting of wood cut into small particles, as sawdust, or the like, substantially as set forth.

12066. "Improvements in or relating to electrical type-writers capable of being used as printing telegraphs." A. J. BOULT. (A communication from J. F. McLaughlin, of Philadelphia.) Dated August 21. 11d. Has reference to improvements in electrical type-writers which are adapted for use in connection with a suitable local transmitter as recorders of outgoing messages sent by said transmitter over a line to a distant station; and also as receivers of incoming messages sent to the home station by a suitable transmitter located at a distant station. In addition to this the improved apparatus may be used for the same purposes as an ordinary mechanical type-writer, but its operation differs from the latter in that the printing is effected electrically. The claims are 19 in number.

12754. "Improvements relating to electric bells and to indicating apparatus for use in connection therewith." H. H. LAKE. (Communicated from abroad by W. Humans, of America.) Dated September 4. 1s. 3d. The object of this invention is to produce a simple, effective and economical apparatus for electrical signalling, and the said invention comprises various improvements in apparatus suitable therefor, certain features of the said invention not being claimed therein, however, as they have been already patented. The claims are 7 in number.

13008. "Improvements in electric incandescent lamps with interior reflectors." J. W. OLDROYD. Dated September 8. 6d. Claims:—1. The manufacture and construction of electric incandescent lamps, with two or more reflectors or reflecting rods, or pencils within the bulb of the same, substantially as and for the purpose set forth and shown on the drawings. 2. An improved electric incandescent lamp containing two or more reflectors or any mere modification of the same, substantially as and for the purpose set forth and shown on the drawings.

13126. "Improvements in electric calls." W. H. CUTTING. Dated September 11. 8d. Claims:—1. The combination of the hand provided with a contact brush, alarm having electrical connections with the hand and with a suitable supply, a number of series of pins against which the contact brush bears, and push buttons interposed in a connection between the pins and the supply, as set forth. 2. The combination of the hand, alarm, electrical connection between said hand and alarm and between the alarm and battery, a ring or cylinder in which are arranged longitudinal series of pins, push buttons interposed in the connection between the pins and the battery, and a contact brush on the hand adapted to bear on each of the pins in the series by means of a series of projections on the brush, substantially as described. 3. In a call system substantially as herein shown and described, the combination of the buttons and removeable tablets having bent fingers on their stems for fitting over the buttons, substantially as and for the purpose set forth.

13194. "Improvements in ungumming and bleaching by electrolysis china grass, rhea, ramie, and other nettles." E. M. H. ANDREOLI. Dated September 12. 6d. Claims:—1. The bleaching, degumming and eliminating all cuticular or colouring matters by subjecting the china grass, ramie or rhea, after it has been boiled in an alkaline lye, to an electric current in a solution of chloride of sodium or other convenient chloride as an electrolyte in which the electrodes are made of charcoal, as substantially described. 2. The treatment of such fibres in an hypochlorite of sodium solution which has been electrolysed and stored, such treatment taking place without passing an electric current through the solution. 3. The use of an electric current as substantially specified in the above described process.

13584. "Improvements in electrical tell-tales." E. MEYER. Dated September 20. 6d. Has chiefly for its object to check watchmen, firemen and others when on duty, and is specially intended for use in such works as brick works where charges of fuel must be made by a fireman at equal intervals of time. There is 1 claim.

13825. "Improvements relating to electrical conductors and insulating conduits therefor." H. H. LAKE. (Communicated from abroad by R. F. Silliman, of New York.) Dated September 25. 6d. Claim:—A single-line electrical conductor and insulating conduit, composed of sections, each section consisting of an electrical conductor, screw-threaded at one end, and correspondingly screw-tapped at the other end, embedded in an insulating material inclosed in a tube shorter than the conductor, whereby one end of the conductor projects beyond the contiguous end of the tube, the several sections so formed being connected, and electrical contact between the respective conductors maintained, by screwing the threaded ends into the contiguous tapped ends of the successive conductors, substantially as described.

13984. "Improvements in electrical accumulators." B. J. B. MILLS. (A communication from abroad by J. Barbier, of France.) Dated September 28. 8d. Claims:—1. In the manufacture of plates or blocks of electrical accumulators, the employment of the new material described, such material being obtained by an electro-chemical action, transforming into peroxide of lead, minium or red lead placed and supported in a framework or body of suitable form and material, substantially as shown and described. 2. In electrical accumulators the process described whereby plates or blocks for the same of desired form can be directly obtained by placing minium or red lead in a framework or body of like form, constructed either of lead, which is itself transformed into peroxide at the same time as the minium or red lead, or of metal soluble in the bath, in which latter case the framework or body would thus entirely disappear. 3. In plates or blocks for electrical accumulators, the process which enables the said new material to be obtained in powder which is afterwards moulded to the desired form and adding thereto, during the moulding process, conductors for the electric current.

14129. "Improvements in and relating to dynamo-electric machines." H. H. LAKE. (Communicated from abroad by Prof. E. Thomson, of America.) Dated October 2. 8d. Relates more particularly to alternating current generators of the kind in which two sets of armature coils are employed, one of which is connected directly to the external circuit which is designed to furnish the alternating currents, the other supplying the current by which the magnetic field of the machine is maintained. The object of the invention is to produce a simple and easily-controlled machine capable of generating alternating currents of high or low potential, as may be needed, and which potential may be controlled so as to be raised or lowered or kept constant by manual or other devices. The invention consists in the novel manner of combining the two sets of armature coils on the armature structure, one set being the field maintaining and the other the working current or line set. The invention consists also in the special manner of constructing and proportioning the armature and armature circuits so as to permit a regulation of the machine to be readily obtained without destructive effects upon the commutator. The invention further consists in details of construction and improved combinations described. The claims are 8 in number.

CORRESPONDENCE.

Electric Lighting in Gothenburg.

As managing director of the Elektron Lighting Company in Gothenburg I take the liberty of correcting a statement in your issue of 6th inst.

Excepting the subscriptions of Baron Oscar Dickson and a few other private gentlemen, all natives of this place, the capital of this company is subscribed almost exclusively by the hotel proprietors, shopkeepers and offices of the town.

The statement that the enterprise has been promoted by English merchants and that half the capital is subscribed in England is only correct in so far as the company has been formed by me and that it was originally intended that half the capital should have been found in England, this scheme being, however, rejected and all the money found here, as the Swedes are not accustomed to throw away some 25 per cent. or so in promotion money, which is shown by the fact that this company's station, for some 3,000 16-candle lamps, is erected at a cost of under £8,000, including triple expansion condensing engines, economiser, and every other appliance for working the station with the lowest possible running expenses, with the result that a handsome dividend is anticipated at the same time that the company can give a 16 C.P. lamp for £1 per shop lighting year of 900 hours.

I may mention that the electrical plant is from Messrs. Crompton & Co., Limited, of Chelmsford.

James G. Calvert.

(*Calvert & Co., Contracting Engineers, Gothenburg.*)

January 17th, 1889.

Bath Electric Lighting.

The tenor of Mr. Massingham's letter affecting my company in your issue of January 11th, and the sympathetic comments thereon in the electrical journals being calculated to create the impression among local authorities throughout the country that they are likely to be denied the benefit of competition in determining to whom they should allot the areas within their jurisdiction, I shall be obliged by your kindly giving the widest publicity to the announcement, that the House-to-House Electric Light Supply Company, Limited, whose engineers have hitherto constructed the only central electric lighting stations for the distribution of electricity throughout an extended area by means of underground mains, is prepared to place its experience in both electric light supply and central station construction at the disposal of local authorities everywhere in the United Kingdom.

The House-to-House Company, as its name implies, has no local predilection whatever beyond the usual commercial inducements, and it will be prepared either to apply to the local authorities for permission to apply to the Board of Trade to undertake the business of supply within their areas on its own account, or in conjunction with local capital, or to erect for local authorities or independent supply companies, central stations on the model of its own at Kensington, which is, by general admission, the most perfect of its kind.

To this end my company endeavours as far as possible to watch the progress of central station development in all towns in the United Kingdom, which, in virtue of their population, present a promising field for the electric light, and its letter to the Bath City Council was prompted by the report of the proceedings of that body, from which it appeared that a contract had been somewhat reluctantly concluded with Mr. Massingham for street lighting only by means of overhead conductors, on the faith of representations to the effect that the present position of electrical science did not permit of the work being accomplished by means of underground mains.

Believing, as my directors do, in the advantage to the public of being supplied under the Electric Lighting Act, which not only requires an underground service but secures rights to the consumer with corresponding obligations on the part of the supplier, they felt that in these circumstances they would be best protecting the interests of the ratepayers of Bath by applying to the Corporation for permission to apply to the Board of Trade to light a limited area of the City for a limited period under a license tenure, and although the unfavourable editorial comments of the electrical journals on their proceeding have been brought to the notice of my directors, they regret to say that they can see no reason to induce them to abandon the step they have taken.

We cannot attempt to justify our ignorance of Mr. Massingham's claims to the consideration of his fellow-citizens. All that we knew about him at the date of our letter to the Corporation of Bath was, that he was a most respectable boot and shoemaker in that city, and all that we have since learnt, on his own admission, is that so far as electricity is concerned he is "only an enthusiastic admirer of the light of the future."

My directors venture to believe, however, that such qualifications are inadequate for the proper discharge of the responsibility of undertaking "to introduce electricity into several towns of the West of England;" but be this as it may they trust that if they should follow Mr. Massingham in extending their operations in the future to such places, the electrical press will not in that event bestow its support on him and withhold it from them.

H. St. John Winkworth, *Secretary,*

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY CO., LIMITED.

January 17th, 1889.

Testing for an Absolute Vacuum by the Induction Coil.

In the interesting paper by Dr. Vander Weyde "On the Absolute Vacuum as a Non-conductor of Electricity," published in the ELECTRICAL REVIEW of the 11th inst., allusion is made to an absolute vacuum tube, into which two platinum wires had been sealed within a quarter of an inch of each other. At first the "spark" is stated to have followed a course outside of the tube in preference to the inside, but eventually by increasing the E.M.F. the vacuum became damaged, and then, apparently, the current passed inside again.

This reference brings to my mind some experience I had a year or two ago with "sparking" and "non-sparking" bulbs, as they were called, and as I have seen no mention of a similar experience in Mr. Crookes's papers, or anywhere else, for that matter, I venture to publish it.

At the period referred to I happened to employ the following method for testing the quality of the vacua during the process of exhausting incandescent lamps. A glass bulb, containing two platinum wires sealed into it and opposite each other, was joined on to each pump, and from time to time, during exhaustion, the terminals of a high tension induction coil were led up to these bulbs, until at length the discharge ceased inside and sparks would appear on the outside. At this stage the vacuum would be deemed sufficiently perfect for the lamps to be sealed off. This method of testing was supposed for some time to give perfectly correct indications; it was, in point of fact, implicitly believed in. However, after a little practical work with the method, it was noticed that some pumps would exhaust lamps much more quickly than others, while sometimes the lamps could not be exhausted, according to the test, no matter how long the pump was worked. Of course the pump was blamed and it was consequently carefully examined, uncertain joints were rehandled by the glass-blower, it was thoroughly cleaned, &c. But it would not unfrequently happen that no amount of attention to the pumps would turn the course of the testing current from the inside of the bulb to the outside. At length, after very considerable annoy-

ance and trouble, the bulbs were suspected of giving false indications of the degree of exhaustion, and a simple experiment was made which seems to show conclusively that the test thus employed cannot be depended upon. The bulb from a pump which exhausted lamps rapidly, and showed a strong and certain external spark without any visible passage of current inside, was sealed on to a pump containing a bulb, which utterly refused to spark on the outside, the pump being then set in motion. It was now found that the bulb which had been in the habit of sparking outside, again began to do so in its customary time, while the other one refused, as usual, to do likewise. Thus, according to one bulb the vacuum was shown to be perfect, but according to the other one the identical vacuum was not so. The same experiment was repeated with different bulbs two or three times, with invariably the same result. It was observed that, as a rule, the old bulbs, which gradually became somewhat blackened with use, were the ones which showed the outside sparking most rapidly and forcibly, but many exceptions to this rule were also noticed. The reason for this rule may very likely be that they were not heated during exhaustion, so as to rapidly free the glass of surface air; but there is no question that this was not the sole cause of the difference in the sparking properly, for in certain special experiments this point was carefully attended to, and still without giving certainty to the phenomena. The results of practical experience were of a most conflicting nature, and I regret that no opportunity has occurred to enable me to enquire more closely into the matter. It may be mentioned in this connection that the outside sparking occurs far more readily when the primary current of the induction coil is in one particular direction, *i.e.*, when the commutator is turned to one side sparking will easily occur on the outside of the exhausted bulb, but if it be turned the other way, no outside sparking will take place unless a strong current is working the coil. This fact, however, I believe is common knowledge.

Legh S. Powell.

Lighting by Vacuum Tubes.

With reference to the foot-note that you inserted in connection with our letter, in this week's issue, we must tell you that it was after inquiry among scientific friends and in all sincerity that we made the statement referred to.

We readily concur with you when you say "attempts" have been previously made in this direction, but we shall be glad to hear what instance you know of similar lighting for more than a few minutes, without keeping an attendant at the break the while.

Pyke & Barnett.

January 21st, 1889.

[The late Sir Charles Wheatstone, on the occasions of the many *soirées* given at his residence in Regent's Park, used to make a feature of vacuum tube lighting outside the house, the continuity never being interrupted throughout the evening. The last happened about 15 years ago and had taken place for many years previously.—EDS. ELEC. REV.]

The Vienna Electric Lighting Rules.

The Electrotechnical Association of Vienna are to be congratulated upon the manner in which they have tackled the subject of electric lighting rules.

As your correspondent, "A. R. M.," remarks in your last week's issue, the rules are definite and precise upon all points, leaving nothing doubtful as to meaning, nor neglecting definite limits where limits are essential, and in this respect a great improvement upon other existing rules.

I think, however, it is a matter for regret that, in defining the limit of current, they should have based it upon the *sectional area* of the conductor—an error that has long since been exposed by Prof. G. Forbes and others.

It is true they limit the current to 300 ampères upon that basis, but 300 ampères upon a basis of 2,000 ampères per square inch section is calculated to raise the temperature of the conductor sufficiently to seriously jeopardise any of the ordinary insulating materials.

When engaged upon this subject some time since, I got out a table for my own edification from the formula of Prof. Forbes, which I append, in the hope it may prove interesting to some of your readers.

Current in ampères.	Ampères for a temperature of conductor y° C. above atmosphere.	
	Per inch diameter.	Per sq. inch section.
1 to 50	400	4,075
50 „ 100	426	2,325
100 „ 200	457	1,319
200 „ 400	475	715
400 „ 600	483	495
600 „ 800	488	376
800 „ 1,000	488	300

The above is calculated for insulating cables, and at once shows the fallacy of a sectional area basis. It will be seen that the heating due to current is nearly constant to the diameter, but not sufficiently so to render the rule absolute.

The only scientific manner of dealing with this subject, in a rule applicable to all cases, is to limit the calculated temperature of the conductor due to current to a certain number of degrees Fah., or Cent., above the surrounding air.

In this country a basis af 1,000 ampères per square inch is frequently worked to, and is found to give satisfactory results in cases where the current does not much exceed 100 ampères; but 1,000 ampères upon the same basis would heat the conductor to something like 375° Fah. above air for ordinary insulated cables, so that 2,000 ampères through the same conductor, as permitted by our Board of Trade, would make things pretty hot.

Few rules that I have seen deal with this subject in a satisfactory manner, but the underwriters of Sweden have a graduated scale that is an improvement upon many, viz. :—

	Ampères per square millimetre.
Arc	2
Incandescent up to 50 lamps ...	3
„ „ 100 „ ...	2·5
„ „ 300 „ ...	2

In conclusion I should like to remind Mr. Preece of his promised formulæ and tables dealing with the temperature of conductors. It will be remembered that in his address before the Society of Telegraphic Engineers and Electricians in May last, upon "Fire Risks and Fire Risk Rules," Mr. Preece found fault with some data used by Prof. Forbes in his formula, the data in question being founded upon experiments by Macfarlane of Glasgow. I hope Mr. Preece does not intend to let the matter rest where it is much longer.

H. Human.

Seeing Sparks.

Was Mr. George Crighton drawing on his imagination when writing to the *Daily News*, or am I behind the times? Where do the electric light wires come from which cross Old Broad Street? It is true there are four or five installations in that street but the current is in all cases generated on the premises, and I know of no central station having mains so far east.

Old Bond Street is a more likely locality for such a pretty sight to be witnessed.

B. P.

January 19th, 1889.